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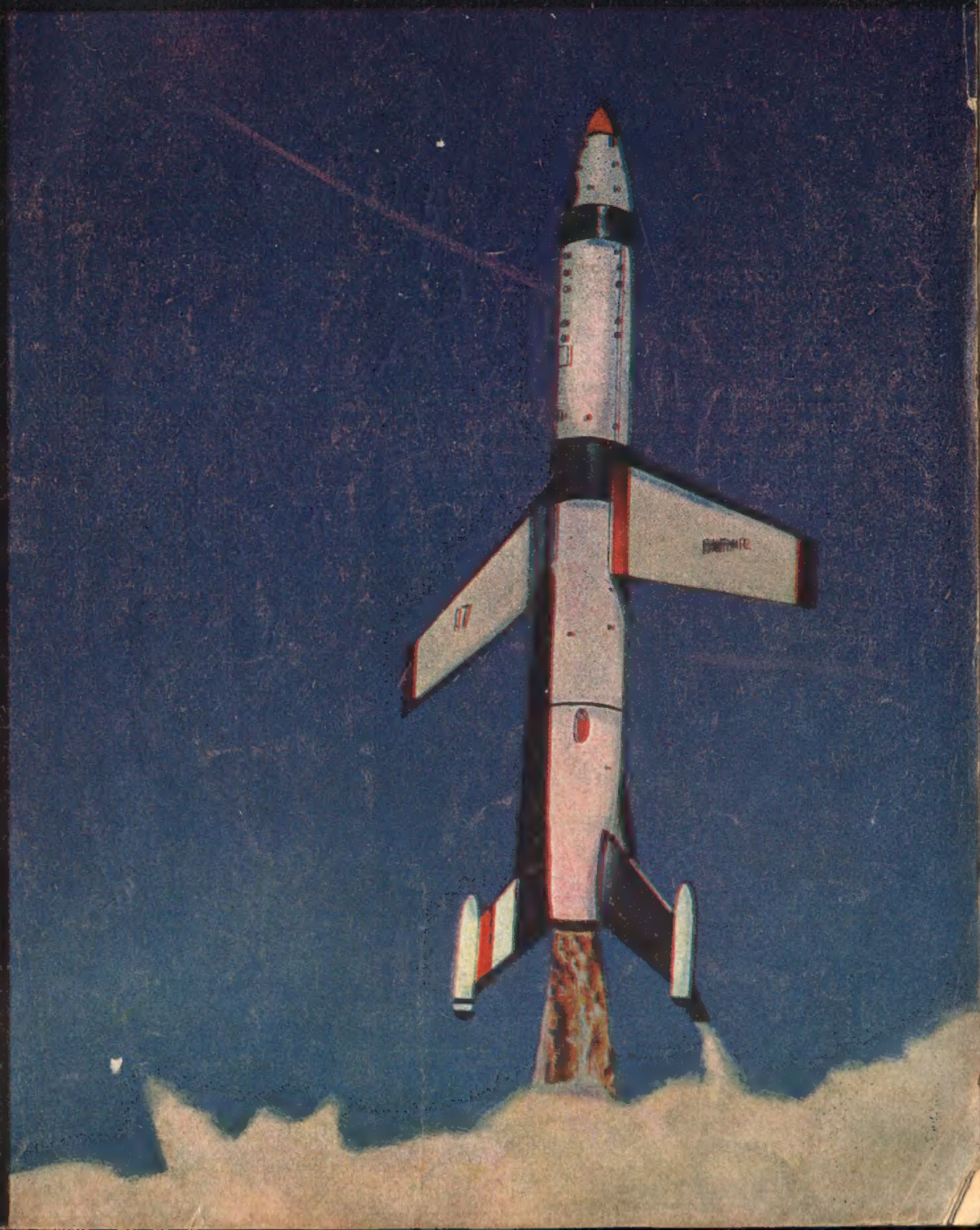
". . . And A Star To Steer Her By" BY LEE CORREY



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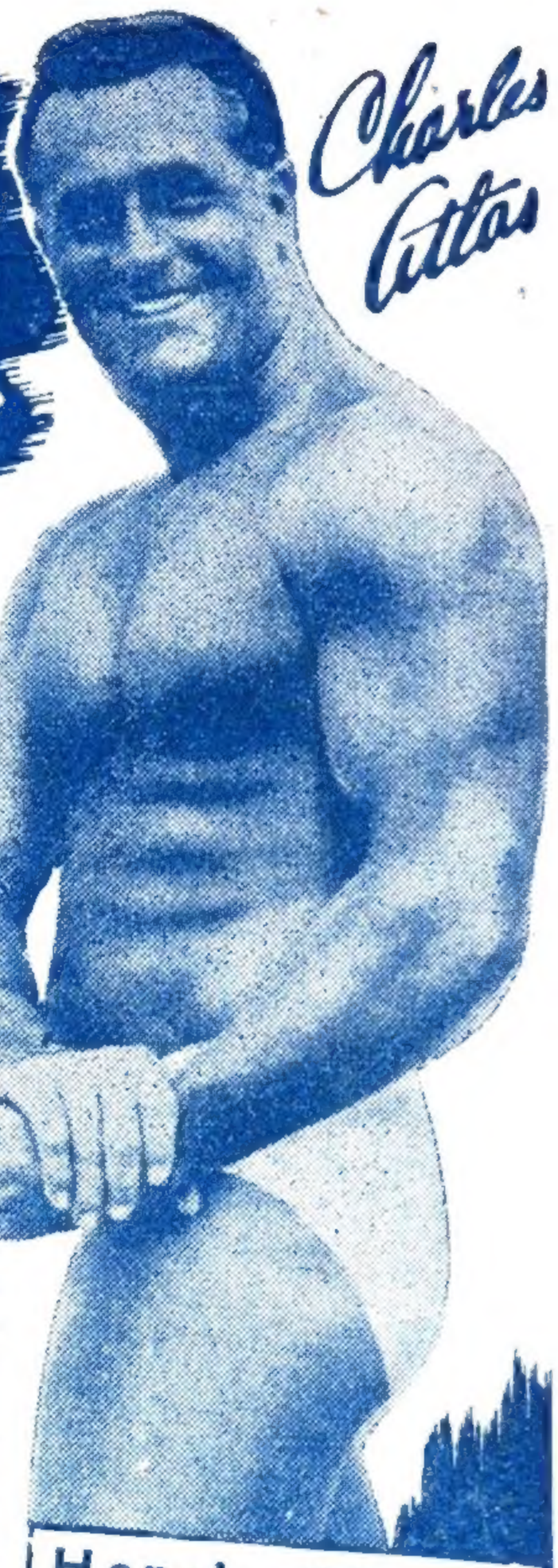

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Astounding SCIENCE FICTION

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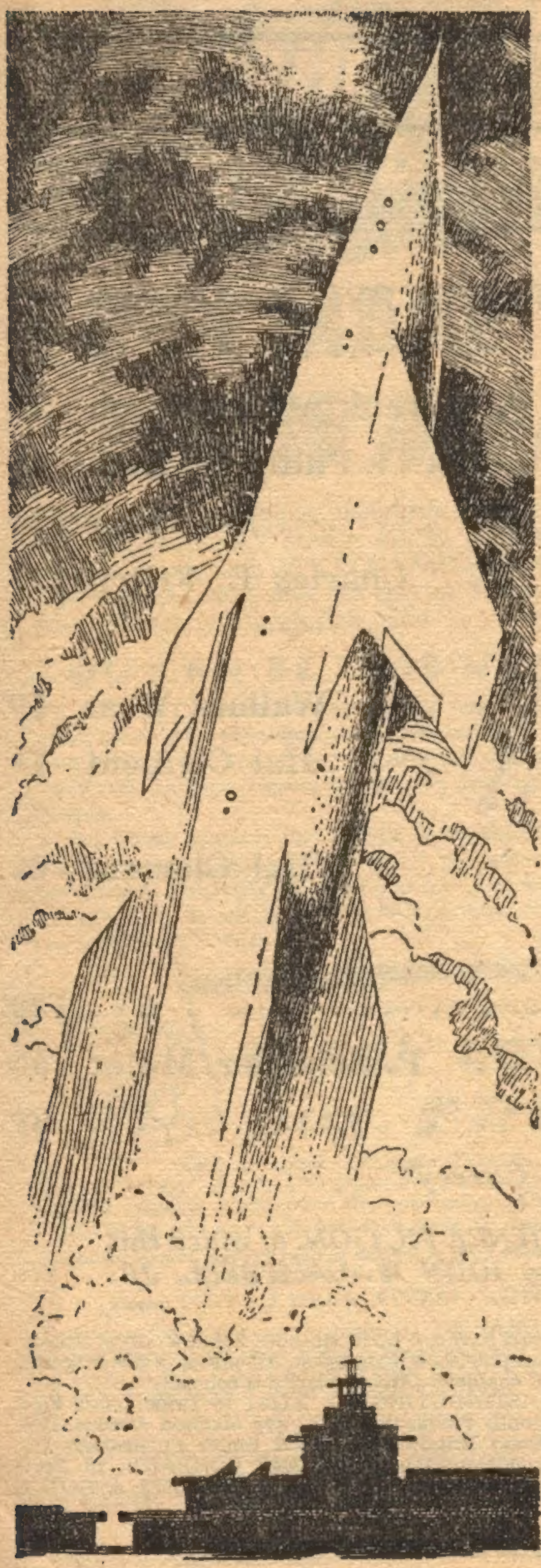
• NEXT ISSUE ON SALE NOVEMBER 20, 1953 •

"...AND A STAR

By LEE CORREY



***A man** works not for any commodity—but for the great Intangible: Satisfaction-as-he-sees-it, And for that, of course, any labor, any risk, is . . . "fun"!*

Illustrated by van Dongen

IN every age, in every time, there have been those who are not content to settle down. They miss the kick of the wheel, the wail of the wind in the rigging, the exotic sights and smells of a harbor half across the world, the roar of engines cutting through the slipstream, and the powerful, body-shaking thunder of the jets . . .

The pain was still etched in Rod Garver's mind. It was really gone now, even though he thought he felt a slight tingle in the fingers of his left hand. But there was nothing there to tingle —only cold, gray metal which was lifeless except when his shoulder and arm muscles gave it movement.

"Fits pretty well, doesn't it?"

"Yeah, but it's going to take me a while to get used to it," Garver replied, twitching his shoulder muscles and flexing the machined joints. "Thanks, Skipper."

Captain Tomaszewski smiled. "Forget it."

"Forget it! It cost you plenty! Great Scott, the machine work is comparable to the stuff they do for pump bearings! You shouldn't have done it, Tom; I'll never be able to repay you."

TO STEER HER BY"

"I said forget it!" Tomaszewski told him. "A man doesn't ride first mate with me all over the System for years and then get dumped when something happens."

"Well—" Garver was silent a moment, then put out his good right hand. "Thanks, Tom."

Tomaszewski took his hand. "Come on; we'll have a drink."

Grinning, Garver nodded. "I need one after two months in sick bay. Lead off!"

The Martian air was cold and clear as they walked along the edge of the canal. The sun had left a red band across the western sky. North along the canal, the towers and stacks of the Canalopolis steel mills were silhouetted against the evening sky, blotching the colors with smudges of smoke.

"What are you going to do now, Garv?" the captain asked.

"I don't rightly know."

"Staying on Mars?"

"No. What can I do?" Garver replied bitterly. "It takes muscles and strong . . . hands to work in the mills. I couldn't do much else here. Space has been my game—all my life."

He looked up into the western sky where a double evening star shone. "I'm going home."

"Terra?"

"Yeah. For fifteen years I've wanted to go back."

He hung around the Canalopolis Spaceport for the next few weeks, watching the ships come and go, sitting around the club of the League of Free Traders, talking shop with other spacemen, and learning to use his new hand. He knew it was all a gag; here he was at thirty-five and probably finished as a spaceman. He knew his power and jets, but a one-handed jetman was worse off than a one-handed piano player. Most skippers would rather have the Venusian Wet Rot.

He might sign on a liner as a master-at-arms or a steward, but he did not have the decorum necessary for such a job. As a first mate, he'd handled people differently. "Besides, you fool," he told himself, "you know you'd go nuts sitting midships while some other guy brought her down on her tail."

He could ride home as a passenger with the tourists and "old space-hounds." No, by the Rings, he'd push a peanut home with his nose before he'd go that way. He'd work his way back—somehow. If he could stick around the League club, something would show up.

It was a tough day for Garver when Tomaszewski lifted the *Timurlane* off Canalopolis for Ganymede. What made it tougher was the realization that he was not going along this time. He loved every sleek line of that ship, and let his eyes take them in as her gantry moved away and left her standing alone and aloof on the pad.

Garver knew what was going on aboard. Minus-15 minutes, red-green light, crew at flight stations, locks closed.

At X-2 minutes, the siren on the tower shrieked, and red lights winked around the perimeter of the pad. Aboard the *Timurlane*, they were strapping down, the control panels were switched to "FLY," the gyros were locked in.

He leaned on the rail and went through the entire pre-flight procedure.

When he saw the ground tackle drop at X-30 seconds, he began his own count-down. He was slow; when he reached X-6 seconds, he saw flame burst from the stern of the ship.

She rose, the colorful Martian desert hills falling away from her. The thundering rumble of her departure echoed back from the red sands, and the trail began to twist as winds caught it.

The sunlight was too bright, he told himself as he wiped his eyes. He needed a drink, and the League Club was close at hand.

The League steward stared at Garver's hand. "You're . . . sure you want to get on the book?"

Garver clenched his hand, moving it slowly, silently, smoothly in a perfectly normal fashion. "You heard me."

Turning back to his papers, the steward looked them over. "Well, I don't know. We don't have anything open right now. I'll notify you if anything shows up."

"Yeah . . . sure . . . thanks." Garver turned from the desk and walked to the door. *Yeah*, he thought, *nothing available for a one-handed man with fifteen years' experience. It'll be a cold day on Mercury before anyone shows up who needs me. Settle down, chum; it may be years before you'll see Terra again.*

The regular routine of the Canalopolis Spaceport went on. Each day, ships would thunder in from the far planets, bringing heavy metals from the asteroids, chemical products from Venus, machinery and cloth from Terra, minerals from Ganymede and Callisto, and radioactives from Luna. They stood tall in their gantries while cargo lifts and cranes loaded them with Martian steel from her iron-oxide deserts. There was a ceaseless procession of ships, the tall freighters, the rotund liners, the stubby ore ships, and the sleek military vessels of Terra.

Attempting vainly to forget them, Garver sat in the League club bar with Angus McBee, a jetman off the *Veda* and an old buddy. He could have picked any number of bars in Canalopolis, but he liked to talk shop with the boys as they came and went—and there was always the chance that the steward would call him.

"Mon," Angus told him, "there are plenty of jobs in space fer ye. Ye dinna have to leave."

"Tell me another, Mac," Garver said as he drained his ginger-high.

"Well, you're pretty handy wi' your hands now—"

Looking at his left hand, Garver discovered that he was holding a cigarette firmly without even crinkling the paper. "Sure, I can control it O.K., but I'll never have any strength in it again. Did you ever try to lift an impeller that weighs one hundred fifty pounds, Earth-weight?"

"Sure, Garv," Angus broke in, "but, mon, you've got a head on yer shoulders. Ye can always rig—"

"*All personnel stand by!*" the loudspeaker on the wall cut in. "*Approaching ship in emergency!*"

They moved in a hurry. The bar cleared in thirty seconds. Although the League building was a good five miles from the nearest landing area, that meant nothing to a ship dropping out of the sky.

Picking a spot near a deep irrigation ditch on the edge of the building's lawn, they turned to watch the sky. People were scurrying everywhere. The non-spacemen were making for the underground shelters. The ground crews and flight crews who had lived around spaceships longer, merely took refuge under trucks, behind walls, or next to holes in the red soil.

"Who's due in?" Garver asked.

"Don't know," Angus replied,

making cups of his hands and scanning the sky near the zenith.

Sunlight glinted off something high in the Martian sky. "There!" Garver picked it up with his eyes and followed it.

McBee saw it, too.

A ship took form against the purple background. It grew as it fell. Then her jets fired with a flash of blinding white. When she began to hover about three miles up, McBee exclaimed, "That's the *Fafnir's* paint design! Vanderhoff must be having trouble. No wonder; she's an old ship."

They heard the rumble of her jets a few seconds later, then the bulk of the League building hid the remaining thousand feet of her descent. The fluttery rumble died, and there was no explosion.

"He got her down," Garver breathed.

"Aye, let's go back to our drinks."

"Jetman First-Class Rod Garver report to the dispatch room!" the loud-speaker cut through the lounge several hours later.

"It can't be!" he exclaimed to Angus as he rose. "It's a mistake! Don't guzzle my drink; I'll be right back."

They couldn't have called me so soon, he thought as he hurried through the halls. He knew it didn't happen this way.

The League steward merely slipped him a sheet of paper, the standard job-offer form, with its brief message:

Ship: S. S. Fafnir.

Commander: Captain P. R. Vanderhoff, F. T.

Location: Landing stage 14, Canalopolis Spaceport.

Job Description: Chief jetman and power officer.

Thirty minutes later, he was standing at the bottom of a gantry crane and looking up at a two-hundred-forty-foot pencil of power-packed metal. The dorsal fin displayed the words: *S. S. Fafnir, Raketenfulgplatz für Raumschiffarht, Deutschland, Terra.* One of the *Ring* Class, Garver thought. Somebody had undoubtedly misspelled her name on the commissioning papers years ago, but that was not uncommon; there was a ship on the Luna shuttle named *Jabberwack.*

The *Ring* Class was a group of good ships, sound and well-built with precision parts made only as the Germans can make them, but old. The retracting landing jack on her ventral side dated her as well as the sharp-angled shape of her fins and landing wings. Her hull was pocked and dented slightly, but the black, white, and red paint design had only been scorched once.

They were unloading cargo from the upper locks. Garver waited for the freight lift to come down, then rode back up.

The man who stood in the lock checking off cargo on a clipboard was attired in the warm orange coveralls of the Canalopolis ground crews. He was a round-faced, gray-haired Dutchman, stockily-built and fiftyish. The battered steamer cap he wore on his head was old beyond description, probably handed down to him through generations for it bore the words, "The Amsterdam Line."

Garver approached him. "Captain Vanderhoff?"

"Yes?" The little man looked up from his board.

"Garver. The League steward sent me over."

Vanderhoff shook Garver's hand quickly. As another load of cargo left the lock, he went back to his clipboard for a moment, then remarked to Garver, "I need a jetman."

"Where are you bound?"

"Terra."

"I'll sign."

Noticing Garver's hand for the first time, Vanderhoff replied, "I said I wanted a jetman—a good one. I've got some repair work below."

"I can do it."

"What do you know? Where have you been? What have you done and how long have you done it?"

"Fifteen years in space, twelve of them as jetman and the last three as first mate of the *Timurlane*," Garver announced.

"Can you handle jets with that hand?" Vanderhoff asked.

Flexing his hand expertly, Garver nodded. "Give me a hoist, and I can put in anything. There isn't a drive system I don't know inside and out."

Another load of cargo came out, and Vanderhoff was silent for a moment as he scribbled on his clipboard. Then, with expressionless unconcern, he ran out a quick calculation on a small slide rule. "All right, Garver. Glad to have you aboard."

Grinning, Garver replied, "Glad to be aboard, Skipper. I'll do my best."

"I know you will. Go aboard and take a look below. We've got some repairs to make. I'll be up in control as soon as I finish checking. Come up and you can sign."

Feeling better than he had in weeks, Garver entered the lock and dropped down the ladder past the fuel tanks. The *Fafnir* was old, but he could see she was sound. She'd get him back to Terra!

Back to Terra! He was going home! Going back to do the things he'd always wanted to do, things he'd never had a chance to do, and things he hadn't done since he was a kid. Going home—

He didn't stop to inquire why he'd gotten the break.

The power room "down under" was familiar. In this class of ship, the fission pile and jets were below with the pile controls and fuel pumps in the power room. The tanks, holding more than sixty tons of fuel, were above him and "forward." The layout of the *Ring* Class power rooms was orderly and functional.

But the *Fafnir's* power room was a mess. Her floor plates were buckled with heat. The pile controls were damaged, out of adjustment, or just out of commission—period. The Number-Four fuel pump was frozen, and leaking lubricant. But the tanks were tight as well as the lines, and the electrical system seemed to be in fair shape.

All the tools needed to put things in working order were racked or around the rack. There was a hoist in the overhead. The ship could not lift in her present condition but Garver could make her fly again.

The place was full of smells that Garver didn't recognize at first. Then, through the reek of oil and lubricants and scorched paint, he smelled something new. It wasn't pleasant; the smell of cooked flesh was most prevalent around the jetman's couch.

Garver knew why Vanderhoff needed a new jetman.

The blowers still worked, so Garver started clearing the air. He opened the hatches to let in light and air, then proceeded to pick up around the place. He'd just hung the remains of the acceleration pad out the hatch when Vanderhoff called him to come forward.

The control room was roomy and comfortable. In her earlier days, the *Fafnir* had been a luxury ship, carrying a full crew of eight as well as passengers. Vanderhoff had converted her to a cargo ship, for Garver had noticed that three of the passenger decks below had been stripped for use as cargo spaces. As a free trader, Vanderhoff had little use for passengers. Cargo

was more profitable—providing the planetary markets did not fluctuate too much while the ship was between them.

There were only two couches. Into the remaining space, the skipper had put a good deal of surplus Space Force gear: a ballistic computer, a prismatic astrostat, a small differential and integral calculator, and a precision novant. There was a large desk around one quarter of the compartment. Vanderhoff was seated at this, filling paper with figures and noting results in little black notebooks. He finally turned around, slamming a notebook as he did so.

"How much profit on the load?" Garver inquired.

"Damn little! Two ships with identical loads were in here three days before me. The demand was yanked down on me," Vanderhoff complained. He pointed down. "Can you fix this tub up?"

"Of course."

"How long?"

After thinking a moment, Garver answered, "Give me three weeks."

Vanderhoff thought this over for a considerable time. Garver could almost feel the man thinking. Finally, cold blue eyes met his. "What do you need?"

"A welding outfit, a jack, a couple of floor plates, some new control rods, and probably a new pump bearing. I'd like to replace the pump, but I don't think we could find another one on Mars."

The skipper nodded slowly. "All right. Go to it. Maybe you can get this clunker working reliably."

"I saw that landing. Nice work."

"It stunk!"

"What happened?"

Vanderhoff leaned back and offered Garver a cigarette. "I shouldn't tell you."

Lighting the skipper's cigarette, Garver replied, "Look, Captain, if I thought my luck had run out, I wouldn't have come over. I don't mind taking chances; it's only when they don't pay off that it hurts. I like your ship. She's going to Terra; I want to go to Terra. What happened?"

There was silence for a moment as Vanderhoff blew smoke. "O'Conner knew, but he'll never tell us. I heard him yell that there was trouble aft before he went."

"Know the cause?"

"Cause?" Vanderhoff exploded. "This tub's fourteen years old! That's the cause!" He quieted down quickly and took several short puffs on his cigarette. "The only thing that holds this bucket together is the mortgage. In fact, the mortgage is so large it affects the mass-ratio!" He broke off and picked up a sheet of paper. "Still want to sign?"

"Why not?"

"Carrying League bond and insurance?"

"I'm still under their bond," Garver explained, "but I've already collected a lump sum on the disability insurance. I'll sign a waiver."

Vanderhoff looked at him. "You really want to get back, don't you?"

"Yes. Where's the dotted line?" He took the paper from the skipper, gave it a quick-glance reading, and saw that it was the standard contract for shares. Scribbling a waiver at the bottom of the page, he signed his name and handed it back.

Vanderhoff glanced at the chronometer as he slipped the contract into the desk. "Hour off for lunch, then get started on that power room." He walked to the bottom of the ladder leading forward to the electronics compartment and yelled, "Winch! Chow down!"

There was the sound of footsteps on

a metal deck, then a head topped with a thatch of black hair peered down the hatch. "Just a sec, Skipper! It's the last of the eight, two down, the Canalopolis steelers leadin' five to three. I just want to hear—"

Vanderhoff put his hands on his hips. "Take your choice: food or baseball.'"

The electronics man stood in awkward silence for a moment, then grinned. "I thought I heard you mention food!" He bounded down the ladder, almost hand over hand.

"Garver, this is Winch Astrabadi—" Vanderhoff began.

"W. Winchell Astrabadi!" Winch corrected him, rolling down his sleeves.

Vanderhoff merely glowered. "Winch Astrabadi," he went on. "Sneak-current boy aboard. Winch, this is Rod Garver, our new jetman."

Winch stretched out his hand and grinned. "Glad to meetcha!"

Shaking hands, Garver tried to size the electronics man up. He was a small man, slightly built, with an air of lazy bravado about him. Although his accent placed him as from somewhere in Greater New York, the square lines of his jaw and the sandy tan of his complexion were those of the Arabic race.

Garver knew men pretty well, and he decided Winch would be a good lad to have around, whether for dovar data in the asteroids or in a barroom scrap. The old first mate had him pegged right away as one of those men who knew his stuff and liked his job, who could think fast and straight in a tough spot and spit in danger's face.

Winch glanced momentarily at Garver's hand, but didn't say anything about it. If the skipper thought a one-handed jetman could do the job, the electronics man was willing to accept it.

Vanderhoff busied himself at the desk, putting a few things in his pockets and shoving other things into the desk. "Let's go."

Winch climbed the ladder again until his head was in the compartment above. "Come on, Cosmo, boy. Time for chow! Easy now; you're not in free fall!" He returned with a rangy yellow tomcat in his arms. Petting the mascot, he went on, "Cosmo, meet Jetman Garver."

Cosmo merely looked disdainfully at the new member of the crew until Garver reached out and rubbed him under the chin. The cat stuck his jaw out and enjoyed it. Garver was now on temporary probation.

As Vanderhoff started down the ladder, Garver looked around. "Where's the rest of the crew?" he asked.

Winch looked at him impatiently. "You're thinking we maybe need a bigger crew? The *Fafnir* ain't no liner!"

Which was true, Garver then realized. Vanderhoff, in the interest of cutting costs, had cut the crew to the bone. The skipper probably did his own piloting, all the astrogation, and handled the control room jetman's job as well. Being "sneak-current" man, Winch undoubtedly took care of communications, dovar and radar, and electronic control; which left Garver with the job of chief jetman, power officer, air officer, maintenance officer, and ship electrician.

Quite a job. Jetman on the *Fafnir* called for a jack-of-all-trades. With his experience, he could handle it—and he had an idea it would be interesting, especially on a ship in the *Fafnir's* condition.

In the League club Garver ran into Angus McBee again as he went to the cigar stand to pick up some cigarettes.

"Ye dinna come back, so I took yer

drink," Angus remarked. "Dinna want to waste it, even though it was bourbon."

Grinning, Garver told him, "Forget it, Mac. I'll buy us both one tonight."

"The call was no mistake?"

"Right! I'm signed as jetman for Terra! I'm going home, Mac!" Garver was jubilant.

"What's the ship, lad?"

"The *Fafnir* under Vanderhoff."

Angus regarded him silently for a moment. "Oh, so you're the one."

"What do you mean?" Garver's grin faded.

"Did it ever occur to ye, mon, why Vanderhoff signed you on ? "

Garver hadn't thought about it.

"I hate to be brutal about it," Angus sighed, "but I take it you know what happened to O'Conner, his former jetman?."

Garver told him he'd seen the power room.

"Mon, you're the only one he could get for the job. Everyone else turned it down flat in the dispatch room." Angus lit his pipe, making quite a ceremony of it, then went on, "The *Fafnir's* a coffin with jets. O'Conner's the second jetman Vanderhoff's lost. Ridin' the *Fafnir's* like sittin' on an armed fission bomb, mon!"

In spite of McBee's warning, Garver took over the duties of the *Fafnir's* jetman. The ship wasn't in too bad shape. It was old, yes; but it was sound. Garver could fix it, and he could keep it going—at least until she dropped into Terra. As far as he was concerned, it was probably the only way he'd ever work his way home.

He went to work on the *Fafnir's* power room with a vengeance. It had been years since he'd had his hands dirty in a power room, and he enjoyed it immensely. It was his work, and he liked his work; he always had. Within a week, he had the floor plates back in and the shielding tight. He put a coat of paint over the whole works and installed a new pad on the acceleration cot. When he got to the fuel pumps, he had trouble. His left hand simply did not have the necessary strength, but he jury-rigged a number of hasty gadgets and got the bad pump unfrozen. The bearings and the impeller were shot, and he couldn't find new bearings. He got away with makeshift ones by filing and cutting and filling until they worked. Over in the spaceport's graveyard he scrounged other parts until he had enough to rebuild the entire pump.

Vanderhoff was surprised one night when he came aboard after some papers to find Garver still in the power room. He dropped through the hatch and looked around. Garver was tightening lug nuts on the pump casing.

"Say, this looks good, Garv," the skipper commented.

Garver grunted a few times as he tightened the last lug, then racked the wrench and sat down on the couch. "Skipper, a neat power room is just as important as a clean control room."

"I wish you'd been aboard for the last few years," Vanderhoff sighed. "A man like you is hard to find on what I can offer." He looked around, "How's it coming?"

"Can't complain. I couldn't find a lot of parts, but I made out O.K. anyway."

"How'd you manage?"

Garver grinned and wiped his hands on a piece of waste. "You've heard of the old jetman's rules of thumb? If you can't buy it, borrow it. If you can't borrow it, steal it. If it doesn't fit, force it. If you've got to hide it, paint it." He turned to a group of controls over the couch. "You're just in time to watch me check out the fuel pumps."

He kicked a switch. A low whine came from one of the pumps and rose up the scale. The power room throbbed and shook as the other three pumps joined it. As the pump pressure backed up against the injector valves, Garver checked meter readings then turned four knobs. The scream of the pumps changed key as the valves opened and allowed the test fuel, water, to pour down through the cold pile and out through the jet into the splash pit. The noise hurt Vanderhoff's ears; he had never heard the noise of the pumps before, having been in the control room whenever the jets were fired. Garver was used to it.

Finally, satisfied with the test, Garver cut the pumps off. As the sound dropped to something a man could shout over, he yelled, "A little rough! I'll tinker a bit longer!"

The silence that finally settled in the control room seemed strange. The skipper offered Garver a cigarette. "Do you *live* down here?" Vanderhoff asked, looking at his wrist watch. "It's near midnight."

"So it is. I hadn't noticed."

"Did you eat recently?"

"Supper. I came back to check out a few things."

"Going to work all night?"

"If I have to. The ship's got to be ready for the Terra jump when the time comes, and that won't be soon enough for me."

The skipper sat thinking for a moment, listening to the hum of the ship's generator on the other side of the room. "I don't understand why you want to go back to Terra and live on the ground," he finally remarked. "You seem to be a man who loves this sort of work."

"Sure, I love it," Garver told him. He held out his left hand. "This is why I'm going home. I was just lucky to get signed on here. Nobody else will have me, so I've got to go home and start all over again. Besides, I think my luck in space has almost run out."

In the middle of the third week, Garver had the power room in shape to fly again and turned his efforts to the rest of the ship. In spite of what he said, his heart was in his work and he did not notice the passage of time at all. He ran over every inch of the *Fafnir's* two hundred forty feet, checking this and fixing that. He did not frankly see why Angus had called her a flying coffin. For her fourteen years, she was in good shape. She had been well built by the successors of the hands who had developed the V-2.

Garver grew to think of himself as a member of the tight we-group that was the *Fafnir's* crew. Cosmo even grew to tolerate him in the ship, and in the electronic compartment in particular. Vanderhoff and Winch no longer looked upon him as a space bum with only one hand. He knew it and could almost feel it; he was their jetman, a man who'd just had bad luck, a man who knew and loved his work as they did, and a man they knew they could depend on.

He never admitted that anything on the ship was working perfectly; there was always something he had to "tinker with just a little more."

The skipper finally asked him, "Garv, have you tinkered enough now that we can raise ship?"

"Well . . . yes; she'll lift all right," Garver admitted.

"You're a perfectionist," Vanderhoff sighed. "I'm taking on cargo tomorrow morning. We lift at 1600, Mars local time, Friday. See that the ship is fueled and ready."

On lift day, Garver was up at dawn. He was not sure about the response time of the rod control in the "firebox," the atomic pile. He checked it

carefully, hoping the ship wouldn't blow when he pulled the rods and opened the valves.

He grew more nervous as the day wore on. Twice he checked the cargo hold to make sure their load of steel was fastened securely. Going outside, he went over the ground tackle, making sure the magnetic clamps would not foul when they were dropped at X-30 seconds.

It was X-45 minutes when he started up the gantry lift again and met Vanderhoff at the lock. "Secured below?" the stocky little Dutchman asked.

Garver glanced down at the tarmac two hundred feet below. The splash pit was filling with water, and the ground crews were picking up around the base of the gantry crane. "All secure, Skipper."

Contemplating the white sides of the ship, Vanderhoff remarked, "Well, will she lift, Garv?"

"I hope so."

"Aren't you sure?"

"I've done my best, that's all I know. It can lift if it feels like it."

At minus-30 minutes, Garver saluted the jets in accordance with old tradition, then stepped into the lock ahead of Vanderhoff. Inside, the skipper turned to him. "Seal her up, Garv. Let's take our flight stations."

Down in his power room, Garver made a series of hasty, last-minute inspections. He was nervous with that gritting tension of anxiety. His stomach was somewhere between his neck and lower ribs, and it was hard and mighty uncomfortable. Minutes ticked away slowly, each dragging into the next.

At minus-15, he saw the red-green light wink on his board—prepare for lifting. Outside, he heard the siren shriek, clearing the ground crew from the area. There was a rumble as the gantry began to move out of the way.

In control, Vanderhoff started the gyros at minus-12 on the button, and Garver began to change the ship's atmosphere to the oxy-helium space mix.

"All stations report!" Vanderhoff's voice bellowed over the bull horn. Garver climbed onto his cot and picked up his throat mike. "Engineering secure!"

"Electronics secure!" came Winch's voice from the electronics compartment where he would remain until taking his couch in the control room at minus-2.

"Preliminary circuit checks!" the skipper ordered.

Putting his board on TEST, Garver ran a quick check of his power-room circuits. "Power room! Circuits clear and secure!"

"Electronics ready!"

"Power room, energize your firebox!" Vanderhoff snapped.

Carefully, very carefully, Garver manipulated the pile controls, withdrawing the rods a bit at a time until the pile had come up to pre-lift heat. "Firebox hot!"

He heard nothing more as he watched his indicators. The power room was filled with small noises which were amplified by Garver in his tension. The temperature reached a plateau and leveled; the neutron count held steady.

"Minus-5 minutes! *All hands to lift stations!*"

Garver adjusted his straps and laid his head back on its rest, his eyes on the panel overhead.

"All boards clear to FLY!"

Garver felt out the switch on his panel and threw it without looking, knowing by feel that it was the one to put his board on to the active circuits. His left hand felt out the pump switches. The adrenalin in his blood stream made his heart pound against his ribs.

The green light on his board winked out, leaving only the red. Minus-2 minutes. "*Stand by for lift!*"

The room was cool, but the sweat stood out on his forehead. He steadied his hands over the board. He kept thinking of what had happened in this power room before he took over.

"Minus-1 minute! Start the pumps!"

He nudged four switches, and the power room was filled with the incredible noise of the pumps. He checked back-pressures as the needles climbed out of the red segments of the dials.

"Forty-five seconds!" The pumps were up to speed and the fuel pressure normal.

"Minus-30 seconds!" The flick of a switch dropped the magnetic clamps of the ground tackle. The *Fafnir* was now free to lift.

"Steady, now . . . steady," Garver soothed over the scream of the pumps.

"Minus-20 . . . 19 . . . 18 . . . 17 . . . 16—"

"Come on, baby! We're going home!" he whispered to the heart of the *Fafnir*.

"10 . . . 9 . . . 8 . . . 7—"

He didn't pray; it seemed useless against the radioactive fire below him. The ship was suddenly a straining entity of its own instead of a complacent fabrication of metal.

"Five!" He threw a switch. A relay whacked closed.

"Four!" Automatic controls, now out of Garver's jurisdiction, raised the firebox temperature.

"Three!" Another relay threw. The tank valves snapped open.

"Two!" The pumps took up the load and shifted into main stage.

"One!" Lights winked solid green across his board.

"UP SHIP!"

Final valves flipped open. The pumps forced the fuel. The *Fafnir* strained and broke ground, balancing incredulously on a slim pillar of fire.

It was lifting; Garver could feel it, and he knew by feel. He was flattened into his cushions, and the skin of his face was drawn and tight across his nose. It was a labor to breathe. Vanderhoff was using an economical high-g lift.

It felt good. He was going back into space again, back to Terra. He was going to miss this.

The thundering subsonics of the jet faded out after a painfully long time, and Garver felt better although he was still pinned down by acceleration. The subsonics always made him feel queasy and light-headed.

Everything suddenly stopped. Garver's stomach hit his ribs. A green light announced, "Cut-off." The power room returned to quiet as Garver felt his weight drop to nothing. It made him whoozy for a moment; he was going to have to take a bit to get his space legs back.

"Hello, power room!"

"O.K., control!"

"Ship is in free flight. Secure your power room."

Garver grinned. "Roger!" A swipe of his hand across the panel knocked the switches to "OFF." From the port, he could see that the landing jack had retracted all right. He checked at all four bulging ports, floating to each in turn to see if the external assemblies on the ship were all right.

Abaft, the ruddy bulge of Mars was receding slowly. Her canals stood out like inked lines. He could pick out Strymon, Cocytus, Triton, and Lethes as they rounded the girth of the planet. Hellas was brilliant orange while the north polar cap gleamed pure white. In the midst of the red sands, Syrtis Major's splotch of green stood out in stark contrast. Mars was

pretty, all right, but Terra is the prettiest sight to any spaceman.

He checked the power room once more, set the air temperature, checked the line voltage on the ship's generator, and put the smoke filter on the control room blowers. Then he went forward.

Vanderhoff was running trajectory fixes from dovar data. Garver lit up a cigarette and waited, knowing better than to interrupt a skipper in the middle of a trajectory problem.

The skipper finally turned around. "Well done, Garv," he said, smiling. "That was more push than I've gotten out of that power room in many a moon."

Shrugging, Garver replied casually, "Just needed to have someone take an interest in it." He didn't tell Vanderhoff how much he'd worried about that lift—nor that he was worrying about whether the pumps would hold together until the *Fafnir* made ground on Terra.

Distances are big in space, and it takes a long time to get anywhere. Once a spaceship is in orbit, it is like a shell in flight; it will arrive at the other end of its trajectory with no further application of force necessary. So there is nothing for a crew to do but eat, sleep, make occasional checks of the equipment and course, and do routine maintenance. None of this takes much time, which is one reason why interplanetary travel is not for the man who gets bored easily.

The crew of the *Fafnir* was used to it. They were spacemen, not tourists. They cat-napped off and on during the ship's "day," ate when they felt like it, talked, played cards, worked over their equipment, and spent a short time each day exercising with sets of springs to keep their muscles in shape. Two hundred forty-nine days in free fall will cause muscles to deteriorate, and they didn't want to learn how to walk in a g-field all over again.

Two months out from Mars, they were all getting well into the rut. Garver had read a lot of the books in the ship's microfilm library, but went back and read them again just for something to do. Vanderhoff was writing up the log one "day" in the wardroom aft of control as Garver was finishing up "Men and Space," by Groswald, for the third time. His arm around a safety line anchored to a bulkhead cleat, Winch was trying to get some sleep hanging in midair.

Garver had just projected the last page when Cosmo, who was prowling around, found his rubber ball. A cat playing with a rubber ball is amusing to begin with, but put both the cat and ball in a zero-g field, and it becomes hysterical. Cat and ball went sailing about in all directions, rebounding off overhead, deck, and bulkheads. Cosmo turned flips in midair to get his feet "down" for landing. At times, the ball would hover in the center of the wardroom, spinning lazily on an axis, only to be disturbed by the flying handful of fur and claws. Cosmo was good; he had the knack of impaling the soft ball on his claws, thus preventing it from sailing off in some direction dictated by the vectors of a slashing cat's paw.

Garver and the skipper momentarily forgot what they were doing and watched Cosmo in his act. It was a welcome break in the monotony. The cat kept it up until he tired, then curled up in a ball about a stanchion to give itself a bath.

"Cats are fine people," Vanderhoff remarked, closing the log and lighting a cigarette.

Garver gave up too and snapped off the viewer. He took the cigarette the skipper offered him. "You know, Skipper, that display of Cosmo's helps

prove my theory about cats being an extraterrestrial race."

"You don't think they're native to Terra?" Vanderhoff asked in bewilderment.

"Right. Look, they're too well-adapted to spaceships, free-fall, and changing accelerations. They never get their directions mixed up; they always know which way is 'down'," Garver explained with a smile. "I think Cosmo's ancestors either conquered space, or were symbiotes of a race who did."

"Tigers and leopards as well?" Vanderhoff asked. "Same family."

"Yeah, but they're merely mutations of the original strain, *Felis domestica*," the jetman went on, tongue in cheek.

"I don't agree with you," the skipper said, watching Cosmo give himself a cleaning job. "I will admit they're perfectly adapted for space travel. Cosmo keeps himself clean and does a good job keeping the ship the same way. Why, I remember once when we lifted from Terra with a load of wheat for Luna. Had rats. Space knows how they got aboard, but Cosmo—"

Winch rolled over in midair. "Look, you jerks, shaddup, willya? I'm trying to log sack time."

"You've been sleeping off and on ever since we left Mars," Vanderhoff pointed out.

"What else is there to do?" Winch asked. He answered himself, "Outside of prayers five times a day, nothing! I'm supposed to entertain myself playing tiddly-winks?" Winch, among other things, was a good Moslem.

"You *could* fix the landing dovar," the skipper suggested. "It hunts."

"That's my fault when the line voltage wanders with a load on it?" Winch asked in a complaining tone. "That's out of my jurisdiction. Chew out Garver. The generator's his plaything!"

"What's the matter?" Garver cut in. "Don't you have any voltage regulators?"

"Certainly! You think I am not on the stick? My job begins where I take the juice off the line, chum. The fact that it's four-hundred-cycle stuff is bad enough, but ninety jolts where I should be getting one hundred seventeen is too much!"

"You're smart," Garver told him. "You're an electronics man. Figure out a way to get what you want. I do the best I can, and the generator's just not up to it." He sighed. "The thing doesn't pay attention to anything—even prayers."

"Speaking of prayers," the skipper cut in, consulting his watch, "it's about that time Earthside again, Winch."

Unstrapping, Winch rolled over and grabbed a handhold. "Right. Which direction's Terra in now, Skipper?"

Vanderhoff pointed. "Aft and to the port. You can see her if you look. Double-star, very bright."

Winch held out his arm. "Come on, Cosmo boy. We'll see if we can't pick up a ball game somewhere when I finish." Cosmo unrolled himself from the stanchion, pushed-off expertly, flipped in midair, and landed on Winch's arm. He wrapped himself securely around it and began to purr. The two of them disappeared through the forward hatch.

Garver had flipped on the microfilm projector again, but Vanderhoff interrupted his reading. "What's wrong with the generator, Garv?"

Flipping off the projector to save juice, Garver sighed.

"It's a Red Queen's race—just like the rest of the ship."

"What's Lewis Carroll got to do with it? Don't tell me he's aboard, too?"

The captain's sense of humor was going early on this trip, Garver noted.

"You've got to run like hell to keep this ship in spacing shape at all, and you've got to run twice that fast to make any improvements," the jetman explained. "Lousy parody, but the generator's too small. It was adequate once, like some other things aboard, but you've put a lot of electronic gear in this bucket. The generator can't handle the demand."

"Can you do anything about it?" Vanderhoff wondered.

"Nope." Cosmo's ball drifted in front of Garver, so pocketed it, adding, "I'd suggest a new and bigger one when we get Earthside."

The skipper heaved a sigh. "Can't do it."

"How come?" Garver asked. "I can find one cheap. You'll be able to afford it if you make a fair profit on this load, won't you?"

Nodding, the skipper replied sadly, "Yes, I'll make a profit, but it won't pull me out of debt. I've been caught too many times by falling markets, and I'm just too far in to ever think about getting out. Always an hour late and a solar short." Vanderhoff thought back to the many times he'd been forced to sell his cargo at a loss because of a falling market. Whereas being a free trader, picking your own cargo, going where you want, commanding your own ship, all had their points, the chance that you might lose your shirt at the end of the trip was extremely sobering.

"When we get into White Sands," Vanderhoff went on, "I'm going to sell the *Fafnir*. I won't get much for her, but I can pay her off. It's just too much worry, and I can't take this kind of strain much longer. I'm old for a spaceman, and it's about time I retired, I guess. Thank the stars I've been able to save a little money over the course of the years. Not much, but enough to keep an old bachelor going.

"So you see, Garv, you're not the only one who wants to go back to Terra for keeps on this trip."

The time wore on, and the long trip gave Garver a chance to think. When he had the control room watch, he'd strap himself to the foot of Vanderhoff's couch and watch the stars, knowing he wouldn't be seeing them as clear, sharp, and numerous as that much longer. He'd miss the brilliant belt of the Milky Way and the bright pin-points of the first-magnitude stars and planets which had guided him across the System dozens of times.

He began to formulate plans. A man can do a lot with fifty thousand solars. Garver could settle down and enjoy the rest of his life without lifting a finger, but he knew he'd been too active a man to find happiness that way. He'd have to work at something. He couldn't sign on as jetman again if the skipper sold the ship; he doubted greatly if the next owner would want to ship a one-handed jetman.

Perhaps he could set himself up in business somewhere. He didn't want to get too far from the spaceports and the only kind of life he knew, either. And he wanted to be his own boss.

It wasn't until he was griping about the lousy space rations they had to eat for the next few months that he got an idea. Spacemen are not connoisseurs of fine food, but they did appreciate a good meal when they could get it.

Garver was not a restaurateur, but he had certain ideas about food and the tastes of spacemen. Maybe he could start a bar and grill close to the port. He felt he was not too old to learn that business, so he sat down and started thinking and figuring.

It was a welcome sight when Terra grew close enough to appear as a disk

in the ports. Garver grew impatient as the days seemed to stretch out. Winch had no trouble locating Terra five times daily now, and within a week, he was picking up the dovar beacons. The *Fafnir* finally streaked across the orbit of Luna, gaining speed as Terra's field began to take effect. Luna was in opposition to the ship at the time, so Winch did not try to raise Diana Spaceport for astrogational information. But the dovar beacon on Asgard, Terra's space station, came back strong when the electronics man triggered it, and the astrographical section there furnished him with the latest meteor counts and ionosphere data.

The dovar beat began to climb up the scale as Terra's field deepened and they picked up speed. Dovar, sometimes known as doppler radar, used radar's principle of bouncing high-frequency radio waves off an object. But dovar, as it was adapted for spaceships, had one very important difference. Radar waves from a spaceship moving at very high velocities return to the radar set with a different frequency. Since it is nothing more than a standard doppler effect, the relative velocities of the spaceship and the body can be computed, just as it is possible to figure the speed of a passing train by the difference in the sound of the whistle. Thus, Doppler Velocity and Ranging, or dovar for short, could give velocity data as well as range by the mere expedient of comparing or "beating" the frequency of the returning wave against that of the transmitted original.

During the initial phases of the approach, Garver spent his time in the power room. He was worried about those pumps, but he could do nothing until he had parts. He checked and re-checked. With Terra's tremendously powerful gravitational field, going in and out of the planet was real work for any drive system. He just wanted to make sure the ship could fight its way down through that field and land in one piece.

When the time came for the landing briefing, Garver went forward to control. Winch was calmly perched on the ladder to his compartment with Cosmo curled up in his lap. Garver didn't say anything as the skipper was working with the astrogational computers again. When Vanderhoff straightened up and went to write in the log, Garver knew it was all right to speak. "How close are we now?"

"Thirty-thousand miles, more or less," Winch shrugged. "Close enough to see, at any rate. That I like."

"Yeah, I imagine it does relieve a certain amount of worry for you," Garver commented as he took out a cigarette. It was his last pack, and they were a little stale after nine months.

"Sure does," Winch observed," nodding, "but you infidels got worse worries than that. Lemme bum a weed." Garver fished one out and pitched it at him. The electronics man struck a match, waved it to keep it going, managed to light the cigarette, then held the match still. It went out; there can be no convection currents where there is no gravity. He went on, "I picked up the Asgard radio relay today. Good ball game! The Dodgers have a chance at the pennant! Was I glad to hear that!"

Vanderhoff spoke without turning around, "I don't suppose you've done anything as mundane as contacting White Sands?"

"As a matter of fact," Winch replied acidly, "I did. They are waiting for us and are reservin' the usual big gantry. If ya want, I am sure they would oblige with a brass band."

"Unnecessary this trip. You're ready to work with their ground dovar?"

"Certainly! You are thinking I am maybe not on the stick?"

"All right," Vanderhoff sighed and turned around. "How about it, Garv? Power plant ready?"

Garver decided not to worry the skipper by mentioning the pumps. There was a good chance they'd hold, anyway, but Garver didn't know for how long. "Secure below, Skipper."

"How about the gyros? The gears looked pretty dry three days ago."

"I helped Garv put some erl on them yesterday," Winch remarked.

"Is all your gear in shape?" Vanderhoff asked. When Winch and Garver nodded, he went on, "O.K., we'll go in with four normal braking ellipses. First pass at one hundred fifty miles. Take us about ten hours to kill enough velocity to get into the atmosphere proper. I'll make a stall-and-fire landing. Garv, I want you to have those pumps up to speed when she pays off."

That was old stuff to Garver. "Right, Skipper."

From the power room port, Garver watched Terra approach on the first pass. The bulge of the planet seemed to flatten out. The sunset line was right below, cutting through Siberia, across Japan, then south through the Pacific Ocean. Just the eastern tip of Australia was in sunlight. As he watched, the terminator disappeared around the bulge of the planet. They were having a typhoon around the Marshall Islands below. The clouds were piled up like cotton in the big low-pressure area. The *Fafnir* was in a trajectory canted about fifty degrees to the equator, swinging southeast across the Pacific. The perigee of her first pass would occur at the high-noon meridian over the South Pacific.

There was a creak in the hull. The wings were beginning to gain a little lift in the rarefied upper atmosphere. Garver checked the skin temperature. It was high, but not bad.

The ship was suddenly parallel to the surface below and tearing along at a terrific clip. The wings were really lifting now; Garver could feel himself being pulled toward the section of the power room which was "down" with respect to Terra.

Then the surface began to drop away slowly, and he knew the ship had passed perigee. She was on her way out now along an elliptical trajectory, but her velocity was far below that of escape. She'd swing back for another pass in a few hours.

He watched the coast of South America come into view, then went back and checked the fuel-line connections. He was far too worried about getting the ship down to be aesthetic and watch Terra go by. It was beautiful, sure, but he wished he were down on the ground now instead of tearing around in the upper atmosphere.

Anybody can get a spaceship off the ground, but it takes an incredible combination of guts, co-ordination, fast reflexes, and a high math to get one back—at a specific place. Berthing a spaceship on a planet is somewhat like riding around a merry-go-round on a coaster bike. The problem is to get on the merry-go-round with a load of eggs at one particular, predesignated place. This is merely a two-dimensional problem involving the essential vectors; bringing the *Fafnir* in was a three-dimensional problem of the same general type—with a few more variables.

The ground dovar stations at Congreve Field, Ryhnin Spaceport, White Sands Spaceport, and Santa Barbara Spaceport in Brazil were tracking her.

Their electronic eyes watched her as she went around and around the globe. The Asgard space station was also following the *Fafnir's* beacon. All the information was being collected at White Sands and fed into the computers there. In the ship, Astrabadi was making pin-point fixes by bouncing dovar off Asgard's beacon as well as the various spaceport beacons. It was a double-check system working from both ends.

Hitting a thousand square-feet of concrete gently and precisely from several hundred miles in outer space is no mean trick. Human reactions are too slow and too inaccurate. The great-great-grandson of the GCA aircraft landing system was getting set to take over the final phase. As the *Fafnir* came in on her approach, five stations around White Sands picked her up on their long-range screens and began bouncing their microwaves off her hull. Their individual azimuth, elevation, range, and doppler beat data were going into the master computer and landing control system at White Sands.

In case of failure of the ship's automatic equipment, White Sands was relaying the information from the computer up to the ship by telemetering. Vanderhoff had presentations on his control panel showing the ship's altitude, approach speed, and drift.

"Winch! Let's go!" Vanderhoff yelled up the hatch. As Winch sailed through it, the skipper stretched out on his cot and strapped in. He swung the switch panel over him and depressed the intercom button. "*Power room! Stand by to bring her down!*"

"Roger," Garver's voice came back. "Firebox hot! Standing by to start pumps on command!"

Winch finished strapping down, put on his earphones, and threw a switch. "White Sands Control, White Sands Control, this is Spaceship *Fafnir* on landing approach. By for you. Over."

The loud-speaker in the bulkhead rasped, "*Fafnir*, this is White Sands Control. Two-degrees drift north of the groove. Your beacon is S-9 and your path is cleared. White Sands by."

Vanderhoff lay back and watched the scopes and meters in the panel above his head. There was nothing he could do about the drift until he fired. The *Fafnir* was now about fifty-five miles up, ripping horizontally through the upper atmosphere and losing altitude. It was Vanderhoff's job to judge all factors correctly, navigate by White Sands' instructions, pull the nose up, and stall out over White Sands, killing the ship's kinetic energy.

He gave the crew the red light.

"*Fafnir*, this is White Sands Control. Give us a count down so we can check our switching circuits. Over."

"Roger," Winch replied and turned his head so he could see the chronometer. "Five . . . four . . . three . . . two. . . one. . . *woof!* Over."

"Thank you, *Fafnir*. Stand by to synch dovar."

Winch closed his dovar gating circuits and waited for the pulse from the ground to put his system in synchronization. The little pip finally danced momentarily on the face of a scope. "White Sands, *Fafnir's* dovar system in synch. By for you."

It was all a matter of waiting now. The red second hand crept around the clock dial as Vanderhoff watched. He was flying the ship by the seat of his pants. He began to sweat, although the control room was cool.

He watched the pip of light which marked the White Sands' beacon creep across the face of his scope. As it moved closer to the cross hairs, he thumbed a small wheel slightly and

felt the nose come up a little as the hydraulic system worked the flaps in the tail assembly. Their velocity was down to about a mile per second now, but he had to kill it all without entering a high-speed stall.

"Power room, *stand by to fire!*"

"Ready here!" Garver came back. "*Starting pumps!*"

He brought the nose up a little bit more. The air at thirty miles provided plenty of lift at the *Fafnir's* speed, and she began to flatten out and *climb*.

"Pumps to speed!" Garver reported. "Ready to fire!"

The power room light winked green on the skipper's panel.

Sweat stood out in beads on Vanderhoff's forehead as he brought the nose up a bit at a time. The beacon pip crept closer to the cross hairs on the screen.

The spot touched the lateral cross hair—then matched them both. Vanderhoff swung the nose all the way up, strained as his straps cut into him, and waited for the ship to "pay-off."

The gyros cut in automatically as the velocity dropped. The *Fafnir* climbed on momentum, stalled, then hung there balanced by her gyros, her kinetic energy zero.

But her potential energy was still enormous; she was seventy-four miles up.

She dropped, tail first, sixteen feet the first second, forty-eight feet the next second, eight feet the third. He didn't dare let her fall too far; the fins would try to flip her over if they managed to take hold in the atmosphere.

On the dovar screen, he watched the velocity of her fall mount. Checking the drift and setting in the proper corrections, he got ready to fire.

Garver, he thought, *I wish you'd told me about those pumps instead of letting me find out for myself.* He'd inspected the power room a few days ago while Garver was forward and asleep. By removing an inspection plate, he'd seen that the pump bearings were badly scored.

Then, the time came. The *Fafnir's* nose began to wobble slightly as the air pressure against her fins fought the gyros.

"Winch, notify."

"White Sands Control, *Fafnir* ready to fire. Over."

"Roger, *Fafnir*. You are clear and in the groove. Fire at will. Over and by."

Vanderhoff poised his hand over the red button and kicked on the auto pilot.

"Four . . . three . . . two . . . one . . . *FIRE!*"

He couldn't hear the thunder of the jets, but he felt the push. Those pumps had to hold for another minute at least. He might get the ship into a glide if the jets did fail, but it was tricky and very risky.

The auto pilot took its data direct from the dovar and telemetered computer data, figured how long it would have to blast at how many g's to bring the ship down gently, and started correcting so the *Fafnir* would land gently and precisely where she should: in the middle of the concrete pad miles below.

Vanderhoff watched the horizon through the control bubble, fighting the acceleration which changed slightly as the auto pilot recomputed its data. He saw the horizon lose its curve. It did so with alarming speed. What he could see of the surface changed from convex to planar, then became a bowl. The Organ Mountains and Las Cruces came into view. He felt and saw the gentle oscillations of the ship as the auto pilot went on making successive corrections of drift.

The Organs reared up against the

sky, then were obscured in a cloud of dust.

The *Fafnir* settled slowly, her white jet splash spraying over the concrete and down into the splash pit. There was a slight jar as her jack-legs touched and compressed under her weight.

The jets gave a mighty belch, then died.

The control room settled down with a chattering of relays. Lights winked. Micro-switches clicked. The auto pilot flashed a green light, then turned itself off. There was a whine as the gyros shut off.

"White Sands control, this is *Fafnir*," Winch addressed the mike. "On the ground and clear. Thank you. Out."

"Roger, *Fafnir*. White Sands control off and clear!"

Vanderhoff was snapping switches. He was ringing wet with sweat. "All hands report and secure!"

Winch sighed. "Electronics secured." He flipped a few switches and lifted Cosmo from his lap; the cat had ridden out the landing with the electronics man as an added cushion. "How does it feel, chum, to have a floor under you again? Don't like it, huh?"

"Power room! Report!" Vanderhoff snapped into the intercom.

There was silence.

"Garv! Report! Are you all right?" the skipper snapped again.

Winch unstrapped quickly and sat up, silently watching the skipper.

Vanderhoff strode across the compartment and threw the lower hatch open. "Grab the First Aid kit and let's get down there! I thought there was something funny about that landing!"

Piling out of his bunk, Winch groaned as he struck the deck, his leg muscles not used to it. Vanderhoff dropped through the hatch. Grabbing the medical kit from its wall brackets, Winch hit the ladder right behind the skipper, leaving Cosmo sitting baffled on the cot.

Vanderhoff saw oil all over the floor of the power room as he swung the hatch open. Garver was lying on his cot, his eyes closed, breathing heavily. The skipper went quickly to him. "Garv! Are you all right?"

Sighing deeply, the jetman opened his eyes. Vanderhoff noticed he was shaking. Garver shut his eyes again, saying, "Yeah."

"Starfire! What happened?"

"Give me a cigarette," Garver said. Lighting up, he went on, "The impeller blades on Number Four pump came loose just after you fired the jets. I had to shut it off to keep it from shaking loose from the deck. The auto pilot couldn't handle the loss of the jet, so I took over manually to keep the unbalanced thrust from flipping the ship."

"You brought this ship down manually?" Winch asked incredulously.

"Why didn't you call me?" Vanderhoff asked. "I could have done the iob with the dovar data to help me."

"I didn't bring it down manually," Garver explained. "I just overrode the auto pilot. We were on auto all the time, all right. I was just putting in corrections to make up for the loss of thrust and the resulting cockeyed thrust vectors. You couldn't have done that in control." He put his hand over his eyes and shook his head. The skipper could see he was exhausted from his effort. "Let's get out of this coffin! I'm worn out."

The sun was just rising over the low hills to the east of the Tularosa Basin as Garver walked out the lock with Vanderhoff and Winch. The desert air was cool and dry. He shivered slightly in his thin jerkin and was glad to put on the warm green coveralls handed them by the ground crew.

Vanderhoff paused and looked up at the fading stars. Jupiter was riding high at the zenith, bright and steady. Venus was the morning star at the time and hung a few degrees over the eastern horizon. Mars, their starting point, was far below the craggy spires of the Organ Mountains. The skipper yawned. "Well, we might as well go in and get a cup of coffee. No use trying to take care of business until this part of the planet wakes up."

On the way down the gantry lift, Garver noted the oil streaking the sides of the *Fafnir*, marring the white paint. He'd opened the hatch to drain the pump lubricant off the power room floor. Reaching the ground, Vanderhoff and Winch waited while he checked the ground tackle connections supplying power to the berthed ship. He rejoined them as they walked across the pitted apron past the splash pit with its pools of grimy, rust-covered water.

"How does it feel to be back?" the skipper asked.

"Cosmo don't like it," Winch remarked. "Too much g-field." He fondled the cat in his arms.

"It feels good," Garver stated, although he felt clumsy and bogged down in the heavy gravity field. The air was like soup, thick and damp after that of Mars, and cool after that of the ship. He'd get used to it all, even though his leg muscles were cutting up. As they left the concrete pad and shuffled through the sand to the waiting jeep, the dust made him cough slightly.

He'd get used to it, but somehow he didn't feel the elation he thought would be connected with his return to the home planet.

"Want me to fix that pump, Skipper?" Garver asked as he met Vanderhoff for lunch in the spaceport League club.

The *Fafnir's* skipper shook his head. "It'll cost money, and I won't get that money back when I sell the ship. Just clean the place up and let her next skipper worry about it."

"Sell the load O.K.?"

"Yes," Vanderhoff sighed as he dialed his order into the autowaiter, "but not for what it was worth. These gonophs here are worse than the ore traders in the asteroids!"

Garver snubbed his cigarette out and asked, "How much did we clear?"

"I can meet the immediate payments on the ship. You've got about nine thousand solars coming as soon as I get paid for the load. They're coming to pick it up tomorrow."

"Want me to be on hand?"

"Yes. Sort of supervise. After that, notify the government boys to come over and take their 'bricks' out of the pile. I want to get my heart back out of their vault."

The decommissioning of a spaceship really takes place when the technicians of the Bureau of Space Commerce come aboard her and remove the "bricks" of fissionable material from her atomic pile. The bricks are the only part of a spaceship not possessed by the owner. There is no ceremony of decommissioning; with her pile "cold," a spaceship is on the ground to stay.

Mixed emotions played through Garver's mind as he watched the BSC boys go through their ritual with the Geigers and gingerly remove the shiny bricks to heavy lead boxes. Those small units were the prime source of the motive power which had enabled this hulk of fabricated steel and titanium to venture out to other worlds.

He was a little sad and sorry for the *Fafnir*. In spite of all the grief he'd had with her in the last ten months, he

knew she was basically a good ship. With minor changes, she could fly the spaceways for scores of years yet.

But these minor changes would cost money. One hundred thousand solars would put her in top shape, would give her the new pre-heating pressure-differential fuel pumps with their lack of moving parts, a factor which made present-day rockets the most efficient of all machines, pumps which would increase her exhaust velocity and enable her to carry more; would give her new brains and nerves of wiring and calculating machinery which reduced human error to an absolute minimum; would give her the new, lighter, molar-transfer air system; would give her, *in toto*, a fresh start.

That was her next skipper's worry. Garver was happy. She'd served him well; she'd gotten him home.

The only thing that really fretted him was the fact that this trip was probably the *Fafnir's* last also. Nobody wants to put one hundred thousand solars into a newly-purchased ship before he can get it to lift. Vanderhoff's only customer would probably be the junk dealer.

He hated to see any ship scrapped, even one which had nearly killed him. Spaceships were individuals to him; no one likes to see an old friend destroyed because he is no longer of any use. He was attached to the *Fafnir*, and he hated to see her go.

"Did you shut her up tight?" Vanderhoff asked as Garver sat down in the easy-chair next to him. The lobby of the League club was filled with spacemen. Outside, a siren shrieked somewhere on the port as a ship prepared to lift.

"Yeah, tight as a tank" Garver replied. "Winch, I hope you got all your stuff off her."

"Certainly! You think I am not on the stick?"

"Well," the skipper sighed, "that looks like the close of our business, then." He reached inside his new sport jacket and took out his wallet. "Here's checks for your shares, each of you." He handed one to Winch and the other to Garver. "I hate to see you men go. You were a good crew." He got up slowly, having a harder time with the gravity field than the younger men. "Now, I think it's time for a round of drinks—on me."

They ordered up in the bar, and Winch asked the bartender, "Got any cheese?"

"Sure. What kind?"

"Give me a few slices of Roquefort," Winch told him.

Garver recoiled. "Great Space, man, you must like living alone."

"Oh, it ain't for me," Winch grinned back. "It's for Cosmo. He loves the awful stuff." He put the cat up on the bar. Cosmo promptly lay down, looking very disgusted. "He doesn't like the gravity. Free fall suits him better," Winch pointed out. "He's liable to kick off if I don't get him back in free fall soon."

"Are you shipping right out again?" Vanderhoff asked as the bartender brought the drinks and the cheese.

"Yeah," Astrabadi replied, breaking the cheese into small bits at arm's length and putting it in an ashtray for Cosmo to eat. "I went on the League book yesterday. Today I am told I have a job, shuttle service to Asgard and back. All there was. Electron pusher on a stinking rowboat," he snorted. "Well, at least Cosmo and I'll be back in space—off and on."

"Great!" Vanderhoff exploded sarcastically.

Winch shrugged. "It's a job. Sooner or later some deep space dovar man is going to kick off, and I'll get his couch. I want to go back to New Dallas some day! Fine place! Great

ball club! A home run goes near forty miles in Ganymede's field!"

"How about you, Garv? Got that restaurant lined up?"

Shaking his head, Garver replied, "Haven't been off the port yet. Slept in the ship. I'll get down to El Paso tomorrow. Probably won't get anything lined up for a while."

Vanderhoff sipped his drink and thought a moment. "Well, in that case, there's nothing to keep you boys from coming over to my new place in Mesilla Park. I'll whomp up a stag supper."

"Fine!" Garver said with a smile. He picked up his drink with his left hand and offered a toast. He didn't have to stand for this one, according to tradition. "Gentlemen, the captain."

Winch raised his glass. "The captain—God bless him."

The next day, Garver found himself a place to live on the north side of El Paso. His search for a restaurant or tavern was unsuccessful. The real estate dealers had a few listed, but the locations didn't suit Garver. He wanted to have the first crack at the spaceport business, which meant he'd have to find a place on the north side of town. White Sands Spaceport covered an area extending from El Paso north to Alamogordo, cradled between the mountains on either side of the Tularosa Basin. El Paso was the spaceport town.

Giving up the idea of trying to locate a place through agents, he rented a ground car and went looking. He made sure the car's air-conditioning system was working; the midsummer heat was almost too much for him.

El Paso had grown since his last trip through on the *Timurlane*. Space travel was expanding and everything associated with it was expanding, too. The city now contained more than a million heat-prostrated victims.

He spent a day wandering around the Fort Bliss section of the city. Most of the business was concentrated along the broad strip of Highway 54, but there was nary a lot or bare piece of ground along the whole thing. He was about to give up when he spotted an old warehouse about a quarter of a mile back from the highway. The steel in it was good and the cinder block walls were solid. He could not see much of the inside through the windows, but it was empty.

A long search through the records in the city hall told him who owned the place. A run through the classified section of the phone book gave him the restaurant suppliers, contractors, and wholesale food dealers.

Garver was practically in business.

"Well, if it isn't my old skipper!" Garver greeted Vanderhoff near the door of the Traveler's Tavern. "What are you doing down this way?"

Vanderhoff shook Garver's hand. "Thought I'd drop down and see this fabulous place of yours. A few of the boys were over at my place, and that's all I heard about." He glanced around the entrance way with its diffused light and paneled walls. "Doesn't look much like a warehouse to me."

Taking the other's hat and flipping it onto a shelf, Garver took his arm. "As the boy said, you ain't seen nothin' yet. Come on. Now's my chance to repay you for that fine bit of chow I had at your place a couple of months ago!"

He led the ex-skipper across the small main floor dining room. It was softly lit and filled with tables at which men were eating and talking. They were all spacemen from their green coveralls. The air was cool and smelled strangely reminiscent of ship air. Garver had turned the ceiling into a

planetarium; all the stars were there in their proper positions. Vanderhoff spotted Venus hanging over the western "horizon." Mars was riding above it. The Milky Way was just as bright as in outer space.

"I've got a mighty fine moon in this rig, but it hasn't come up yet," Garver remarked as they got into a lift and were deposited on the upper floor.

The room was surrounded by glass through which all of El Paso was visible as well as White Sands to the north. It was early evening and the lights were just coming on in the city. The bar was filled and there were but a few tables unoccupied. It wasn't plush; it just looked comfortable, like a wardroom or a man's den. Vanderhoff felt like sitting down and throwing his feet up on the table.

They sat down by the north windows. Garver ordered drinks and a meal, then said, "Welcome to Traveler's Tavern!"

Vanderhoff looked around. "This must have cost like hell!"

"As a matter of fact," Garver remarked, "it wasn't so bad. I cut corners and used short cuts. I wasn't trained as an engineer for nothing."

"Looks like business is booming."

"All I had to do was drop the word, and the boys came flocking." He stopped and sighed. "Yeah, business is good, I guess."

"What's the matter? I should think you'd be happy that business is good."

Garver took the drink that was set before him and didn't reply for a moment. "I don't know how to explain it. When I was putting this place together, I kept busy all the time. I was working; I didn't have time to think about anything else. Now I have trouble keeping busy. I guess I'm restless. Things are going too smoothly day to day."

"I know what you mean," Vanderhoff sighed. "I've been trying to write up my memoirs. I finally had to get out of the place for the day. Doing nothing of importance, going nowhere—it's got me down."

"Sold the *Fafnir* yet?" Garver suddenly asked.

"Nope. Nobody wants her—at least as a spaceship. Three junk dealers want to bid on her."

"Going to look at their bids?"

"I can't sell her as junk, Garv," Vanderhoff admitted. "I don't want to see her cut up with torches. I'd just as soon leave her out on the pad to rust."

"How about the mortgage on her?"

"Still there. If I don't sell her pretty quick, I'll have to take one of the junkmen's bids."

Garver shook his head sadly.

"Seen Winch lately?" Vanderhoff went on, changing the subject.

"Yeah, he drops in after every trip."

"Still on the Asgard shuttle?"

"Still running a ferryboat." Garver swirled his drink. "You knew that Cosmo died, didn't you?"

Vanderhoff sat up, shocked. "No! How?"

"Poor animal forgot it was in a l-g field about a month ago," Garver explained. "Fell off a gantry crane at Bonneville trying to catch a bird. Winch is the lonesomest character you'd ever hope to run into."

Vanderhoff said nothing, but looked out the window. Away on the horizon to the north there was suddenly a cloud of dust and a vapor trail climbing high into the evening sky. "Wonder where she's going?" the old skipper thought out loud. "New Denver? Canalopolis? Perrine? Roemer? What would you give to go back, Garv?"

"Why should I even want to? I've got a prosperous business here. What would *you* give to go back?" he threw the question back at Vanderhoff.

"I can't."

"Why? You've still got a ship."

"I'm older than you are, Garv. The doc told me yesterday I'd better quit thinking about it. No good for acceleration any more." He settled back in the comfortable chair and then put his feet up on the table. Garver didn't seem to mind. "It wouldn't be so bad if I had something to do like you. It's just hard to retire to nothing."

"Well, now, why don't we—" Garver began.

There was a sudden interruption at the bar. A small, dark-haired lad began mixing it up with a tall, big-boned Swede. Customers cleared the area in a hurry. The little man went down amid a clatter of barstools, but was immediately on his feet again and wading in with ferocious intensity.

Garver came to his feet instantly. The bartender vaulted the bar and started to break it up, taking on the Swede, who was more his size. Garver waded in with the idea of breaking the small man away. Vanderhoff was right on his heels, a match box clasped in one fist.

Grabbing the youngster, Garver was surprised momentarily when the scrapper turned on him. He felt the other's foot scrape down his shin and land painfully on the small bones of his foot. That made him mad. He got in close and held the youngster in a front bear hug. In one quick, smooth motion, he brought his metal hand around front in close to the youngster's chest, then let him have it with a short, easy, upward chin jab. He felt the crunch of teeth as his metal palm made contact.

He let him fall and turned to find the Swede pinned by the weight of the bartender and three others. Vanderhoff was standing against the bar with a bottle in one hand, ready to let the Swede have it if he didn't calm down.

"O.K., what goes on here?" Garver snapped, rubbing his bruised shin.

The Swede struggled briefly. "Let me at that smart young punk! I'll—"

"Shut up!" Garver roared his roughest first-mate voice. He turned to the three men who had been sitting next to them at the bar. "Who started it?"

"Well," one started to explain, "Swede here was kidding Shorty about his southern accent. The kid told him to shut up, and Swede don't take that kind of stuff off kids."

"Let him up," said Garver. Swede got to his feet, looking big and brawny. "Pay your bill and get out!"

"Look here, you little—"

Garver stepped up to him and clenched his metal hand. He stood a good five inches shorter. "I said pay your bill and get out! You'd look funny picking up your teeth with a broken arm!"

The Swede hesitated a moment, took a long look at the hand, then flipped a ten solar note on the bar and stalked out.

"This happen often, Garv?" Vanderhoff wondered.

"You ought to know spacemen," replied Garver. Looking down at the still form of the youngster, he told the bartender, "Joe, take him down to my office and heave him on the couch."

"What's your name, son?" Garver asked as the youngster came to and sat up.

Three of his lower teeth were gone, but there was still fire in his eyes. He spat blood and answered, "Bernotte, suh. Harvey Bernotte."

"What's your ship?"

"Ah ain't go none no more, suh."

Garver walked to a wall locker and poured a brandy. "How come? What happened?"

Bernotte swung his legs to the

floor. "I was on the *Scopas* until the mate decided he didn't like the idea of his jetmen swipin' the sick bay's alcohol," he replied. "I got the list yesterday when we grounded."

"You got a home on Terra?" Garver questioned as he returned with the brandy.

"No, suh, my folks is farmin' in New Dakota, Venus. I guess I shoulda stayed home and helped with the crops."

Handing him the brandy, Garver sat back down. "How long you been in space?"

"Two years, suh. Got on the League book when Ah was eighteen. Mah folks didn't approve; said it wasn't right for me to go skedaddlin' all over Creation. Maybe they was right. Don't look like Ah'm going to get back there for a while."

"Tough luck," Garver shook his head. "Kill off that brandy, pay your bill, and go see a dentist."

Bernotte drained the brandy in one swallow. "Ah can't."

"No money, huh?"

"Right."

"Well, I'll tell you, I need another bartender topside. Ever tend bar?"

"No. Ah can learn."

Garver reached over and pressed a switch. "Joe," he told his bartender, "I've got a lad here who's going to work off a bill. Crack the whip over him."

"Sure thing, boss. Send him up; I can use him."

Jerking his thumb at the door, Garver told Bernotte, "Report to Joe at the bar."

"What happens after Ah work it off?"

Shrugging, Garver told him, "You can stay or not, as you please. Lots of guys here like you. Joe's a three-time lister himself. We can use you."

Three weeks later, Garver was up in the bar seeing how Harvey was running the place. Joe had been lifted from the black list, and the little Venusian with the Old South accent had taken over. Business was slack, so Garver sat down by the north windows where he could watch the ships at White Sands and called Harvey over for a chat. Harvey, knowing the boss would want it anyway, brought a ginger-high over with him.

"How do you like this job, Harvey?" Garver asked as the bartender sat down. "Getting along all right?"

"Sure," Harvey said with a grin. "It beats workin'."

"This isn't work?"

"Naw, not when you've tried to run a thousand-acre farm on Venus, boss."

"Still want to go back?" Garver wondered as he raised the glass to his lips.

Producing a toothpick, Harvey tossed it in his mouth and began to chew it. "Mebbe, mebbe. If Ah can ever get lifted from the black list, Ah'd like to kick around the System for a spell. Ah ain't been nowhere but Venus, Luna, and here. Some day Ah'll ship back out as jetman and get a look at these here other planets around us. Farmin's O.K. fer some people; but Ah'd go back to it right now if Ah had the chance, and forget all this skedaddlin' around."

Garver started to say something, but heard a familiar voice behind him. "Well, I'll be damned! You made it back after all!"

Tomaszewski, captain of the *Timurlane*, slid into a chair at the table.

Garver got to his feet. After the two old friends had appropriately greeted each other, Garver motioned to Harvey. "Harvey, this is Captain Tomaszewski," he told the jetman-bartender.

"Bring him a drink, and anything's on the house for him—any time."

"Like hell!" Tomaszewski objected. "I'll pay for what I get!"

"Like hell you will!" Garver fired back. Harvey went back to the bar. "Harvey's a pretty good jetman," he remarked. "A little young, but he's got what it takes. Got the list. The boys on the *Scopas* didn't like him swiping the medicinal alky."

"Yeah, their mate's a religious sort of guy," Tomaszewski added.

"When'd you get in?"

"Just this morning." Tomaszewski leaned back in his chair and crossed his long legs. "Back from Ganymede."

"How's New Dallas?"

"Growing like crazy!" He went on to describe how New Dallas and the sovereign state of New Texas on Ganymede had progressed, paying particular attention to the number of new bars and dives.

The sun went down, but the conversation kept going. Tomaszewski told how they'd torn down and overhauled their power room during the months they were in trajectory, how the ground dovar at Diana Spaceport had gotten fouled up and almost brought them in for a landing on top of another ship.

Garver sat and took it all in. Somehow, he was a little sorry he'd left, but he was settled now. He wouldn't have to worry about cash the way business was growing. But he grew nostalgic. His mind's eye saw New Dallas again with its wide open bars and wild frontier life. He remembered the sparkling of the dovar screens as the ship rode with the drift through the asteroids. He could almost see the cold, dark sky of Luna and feel the powerful, bone-crushing, body-flattening push of high-g.

He wouldn't admit to himself that he missed it all.

It got too much for him, though. He couldn't sit around and attend to the routine of running the restaurant any longer. On the pretense of dropping up to see Vanderhoff in Las Cruces, he stopped by White Sands.

The desert was flat and the sun was hot. Traffic on the roads was heavy with the bustling activity of the big port. Hundreds upon hundreds of tall ships and orange gantrys reared up out of the flatness of the Basin. In the main port building, he noted by the board that the *Scopas* was lifting shortly. He went out to watch her.

She was a big ship, four hundred feet of beautiful, sleek metal symmetry. Too high for a gantry, she was serviced by four tall towers, with large cable cars running like bosun's chairs to her locks and hatches. Her crew had already cast all but one of these loose by the time he got there. Taking up a position on the ramp of the control building a mile away, he watched her get ready to go.

There was power in every inch of her lines, from the pointed nose down along her slim sides to the gaping orifices of her jets. She was one of the most efficient machines ever devised by man, a machine which allowed him to defy the gravity holding him to his world and allowed him to exercise dominion over the tiny dust-motes in space around a small star. To mankind, it was a tremendous achievement.

Garver had once been part of that.

The bull horn on the tower boomed, "*Minus*-15 *minutes!* All hands clear the area!" The siren began to howl. Men and machines scurried away from the ship, looking like insects in comparison with her huge bulk. Red-green lights winked on around the area.

The minutes dragged by. Garver felt the old excitement welling within him. Then, the green lights winked out, leaving only a circle of red ones about the ship and on the tower.

The *Scopas* suddenly came alive. Fire burst from her stern, lifting the desert sands in swirling eddies. It took her a moment to move. Then she balanced on a solid pillar of fire so white it hurt his eyes. She was high as her own length.

He cupped his hands over his eyes to see her better in the bright sun. The noise struck him. It was a solid wall of sound. He doubled over instinctively, as though he'd been punched hard in the stomach by a monster fist. As he watched, that tremendous thing as high as a forty-story building climbed up into the blue with gaining speed, leaving a hundred-foot trail of flame behind it.

He had spent years in space. He'd watched hundreds of them go up. But he never got over the awesome feeling of the horrible power of those ships. No one ever does. It is an emotional experience that cannot be equalled by anything else.

She was gone. The rippling thunder of her departure finally died, leaving nothing but the vapor trail to show where she had been.

On the way back in, the road led him by the original blockhouse and launching area of White Sands. It stood now as a monument and museum of those days when men longed for the planets and sought them with the pitifully-small chemical-fuelled rockets. He stopped for a look. He hadn't seen the place for years. The old blockhouse was just the way it had been the day the first rocket had left from Luna, leaving her boosters and steps in the desert and the Gulf of Mexico. The racks of electronic gear in the firing room were ancient, bulky, and long outmoded. Through the small slit windows with their ten-inches of glass he could see only a portion of the launching area, although the periscopes offered a somewhat better view. He wondered what the men had been like who'd sat in here and fired those old blowtorches. He wondered what they'd thought as they fired that first one at Luna with a barely adequate load of fuel. Had any of them known what they were ushering in and what a tremendous boon to mankind the frontier in the sky would be? In the communications room he looked at the plotting board where they had watched the boosters and steps fall Earthward in streaks of red grease pencil.

Outside, the little gantry still stood over the firing pit. Sitting on the firing table beneath it was Betsy, the old V-2 war rocket which had never gone up. They painted her each year now to keep her from rusting.

On her south fin was a small brass plate:

GERMAN V-2 ROCKET
as fired at White Sands Proving Ground
1946–1951 A.D.
The first rocket with pumps and
the ancestor of the spaceship.
Ad Astra per Aspera.

He turned and walked away. A mile ahead of him was an orange gantry crane and the *Fafnir*. Her sides were streaking with rust now, but she stood tall and straight and proud, rearing high over the desert boondocks.

Then he knew he belonged here. This was his life and always would be. Somehow, some way, he must live it. He *had* to go back into space—*had to*. He couldn't live his life cooped up on this tiny planet, eternally chained to her by her gravity. He'd been kidding himself all along. He'd thought he could change. He couldn't. He knew he never would. This is what he'd always wanted to do.

Thousands of men had lived for the very thing he'd done, had given their

lives to put a rocket on the Moon, had sweated on the hot, dry desert of New Mexico to throw a V-2 a hundred miles into the sky, had been laughed at as fanatics, had lived and breathed and talked and dreamed rockets all their lives. Men like Oberth, Ley, Winkler, Goddard, and those who had followed in their footsteps, sharing the dream, believing—knowing it could be done and would be done.

He didn't bother to wipe the tears from his eyes. He had to go back.

The patio of Vanderhoff's small house was cool in the evening air. Somewhere a *chicada* was singing its song. Vanderhoff offered Garver a cigar. "You said you wanted to talk business. Shoot."

Declining the cigar and taking out a cigarette, Garver leaned forward in his chair with the white cylinder between the fingers of his left hand. "Have you sold the *Fafnir* yet?"

"No. Why?"

Garver breathed a sigh of relief. "What do you want for her?"

Vanderhoff didn't even look surprised. He puffed leisurely on his cigar. "I'm not sure I want to sell," he said slowly.

"I'll make you a deal," Garver put in quickly. "You were complaining that you were going stir-crazy for lack of something to do, right?"

"Right."

"I have an answer. You've got the *Fafnir*, and I've got the Traveler's Tavern. Want to swap?"

Vanderhoff looked at him, startled. "You're crazy!"

"No, I'm serious. I want the ship."

"It's old. It won't lift."

"I know that. I know what it needs. I know how to fix it. I made her fly once before."

Shaking his head, Vanderhoff told him, "I won't swap with you, Garv. I'd be robbing you."

"All right, tell me how much you want for her!" Garver exploded. "I'll sell the restaurant and give you cold cash!"

"Now, now," Vanderhoff soothed, "don't blast off with your locks wide open. I didn't say I wouldn't do business. First, I want to find out something. You're pretty sharp at this tavern business. Inside of four months, you've made a new and expensive place pay off like a game of Luna Jug-a-rum with a green dealer. You've got talents in that direction. Why do you want to give that up?"

"Van, it's the difference between toil and work," Garver told him. "Running that place is *not* what I *really* want to do. I've discovered that I don't have to."

"Got the old sky fever, huh?" Vanderhoff chuckled. "Nobody to hire you, so you go back anyway as your own skipper, eh? Why in the name of Saturn's Rings didn't you decide that months ago?"

"I thought I could change," Garver admitted.

"Nobody can change their basic make-up," Vanderhoff pointed out. "You were in space because you liked it; you had to like it to stick with it fifteen years. It became part of your own personal make-up. You know men, Garv; you were a first mate. It's a wonder you didn't see it."

"I knew men, all right," Garver said quietly, "but very few men know themselves."

"All right, Garv, you want to go back." The old free trader pointed his cigar at him. "But tell me this: *how are you going to make it pay?* That was the main reason I had to leave. I'd have kept going otherwise until I dropped dead on the deck. My family have been traders and merchants and merchantmen skippers ever since the Fifteenth Century. I grew up with the ledgers and ware-

houses and exchanges all around me—and I couldn't make it pay! How do *you* propose to do it as a free trader?"

"You made a mistake," Garver pointed out bluntly. "You grew up with the businessmen who had been chained to Terra for centuries. They had no more conception of interplanetary trade than the average man on the street does today. I grew up with the ships that ply the routes between the planets. I know interplanetary commerce from *all* its varied angles. Sure, a ferryboat skipper can't see how transoceanic steamers can make a profit with their tremendous investment, long voyages, and changing markets. With the same token, the terrestrial businessman has trouble visualizing a profit when he can't ship forty tons by sky freight and get it there in a matter of hours. It's all a matter of viewpoint. Van, I've shipped for years with free traders who could and *did* make it pay!"

Vanderhoff watched the smoke from his cigar drift slowly in the evening breeze. The last bits of color were fading from the western sky. "All right, I'll do business with you, but I've got more questions, ones which will need to be backed up by figures." The old Dutchman got up and put out his cigar. He turned and added, "You see, Garv, I'm no horse trader. My people taught me the ethics of the trade—and there are ethics to commerce. I drive a hard bargain, but I couldn't outright cheat a man any more than a doctor can administer poison. Let's go look at the books so we can get a square deal."

The *Fafnir* was ready to go again. She stood out starkly white in contrast to her gantry. Gone were the streaks of rust; her skin was welded and hammered out and painted. Her insides were clean and re-organized. The jets had been lined with R-26, the new refractory material, and were fed by pre-heating pressure-differential fuel pumps. Winch Astrabadi, whom Garver had hauled off the Asgard shuttle, had put in the new dovar which was hidden in the radomes bulging out from the hull, and had helped Harvey Bernotte rewire the entire ship.

"Minus-45 minutes," the *Fafnir's* new skipper remarked, checking his watch. He turned to Vanderhoff. "Hold down that fort, Van. I think I've shown you all the ropes at the Tavern."

"It'll do all right. I'll send the monthly reports to New Dakota Spaceport so you can have them all when you get down on Venus." Vanderhoff was now the operating partner of the Tavern, having traded the *Fafnir* for half-interest. They had arranged a complicated deal. In brief, they had it fixed so Vanderhoff could buy off Garver's interest; Garver planned to use that money to pay off the loan with which he'd rebuilt the ship. There were a number of clauses in the contract which allowed for payments on the ship from the proceeds of the Tavern in case Garver got into trouble. In all, it was the strangest outfit that ever put a ship into space.

Winch leaned against the gantry, impatiently shifting from one foot to the other. Cosmo II was wrapped around his neck like a fur piece. "We'd better get aboard, Skipper. Harvey's yelling out the lock. Why'd you have to blast off at prayer time?"

"Want to recompute the orbit?" Garver asked. "Go get your gear warmed up. I'll be up in time." He turned to Vanderhoff with a smile as Winch went up on the gantry lift. "Winch's impatient to get back. So's Harvey, and even more so in his case. He finally decided he's going home to

Venus. Wants to take up an honest occupation on his folk's farm there. He won't stay."

The old captain nodded knowingly. "He's just like you, Garver. You wouldn't admit it, though, until it hit you between the shoulder blades. I knew you wouldn't stay here long."

"Oh?" Garver looked surprised.

"Sure. You stayed longer than I thought you would. I really got to know you that night in Canalopolis when you were working on the old pumps. You were in love with that machinery, Garv. I knew you wouldn't leave it for long. You fooled me a little, though; I had a hell of a time holding on to the ship for you."

"*What?*"

"I never put the *Fafnir* up for sale publicly," Vanderhoff admitted with a smile. "You could buy her, and I was in no real hurry. I had the feeling you'd come around in a couple months. I never figured on getting a restaurant with all its business in the deal, though."

Garver's expression was somewhat stupefied, then he broke out in a broad grin. "Why, you old space rat! You're pretty sure of yourself, aren't you?"

"No, not at first. But I was sure of you. The loss of your hand was bound to make you a little bitter at first, but everyone adjusts. Harvey's a little bitter at the universe now, too. Time will take care of that. Just hang on to him. Winch, too," Vanderhoff advised. "They both like their work. They'll run shuttles if they have to in order to stay in the game."

"Hey, Skippah! Minus-35 minutes!" Harvey's drawl drifted down from the power room lock. "Let's get this here skyrocket off the ground!"

Holding out his hand, Garver remarked, "Got to go aboard or we won't get into our orbit for Venus. I should have gone to sea; the ports don't move. Good-bye, Dutchman."

"You're the Dutchman," corrected Vanderhoff, "doomed to sail forever. You'll never be content at home."

Garver glanced up the long white hull of the *Fafnir*. "That's home," he suddenly realized and said out loud.

Thirty-three minutes later, Vanderhoff stood statuelike outside the control tower and watched the *Fafnir* lift. This time the old Fire-breathing Dragon lifted true, straight, and fast.

Up and out the *Fafnir* drove, her steel heart singing with the sounds of well-functioning machinery, carrying Rod Garver out to his destiny. Every man has only one destiny, and he shapes that during his life by the things he likes and the things he does and the places he goes.

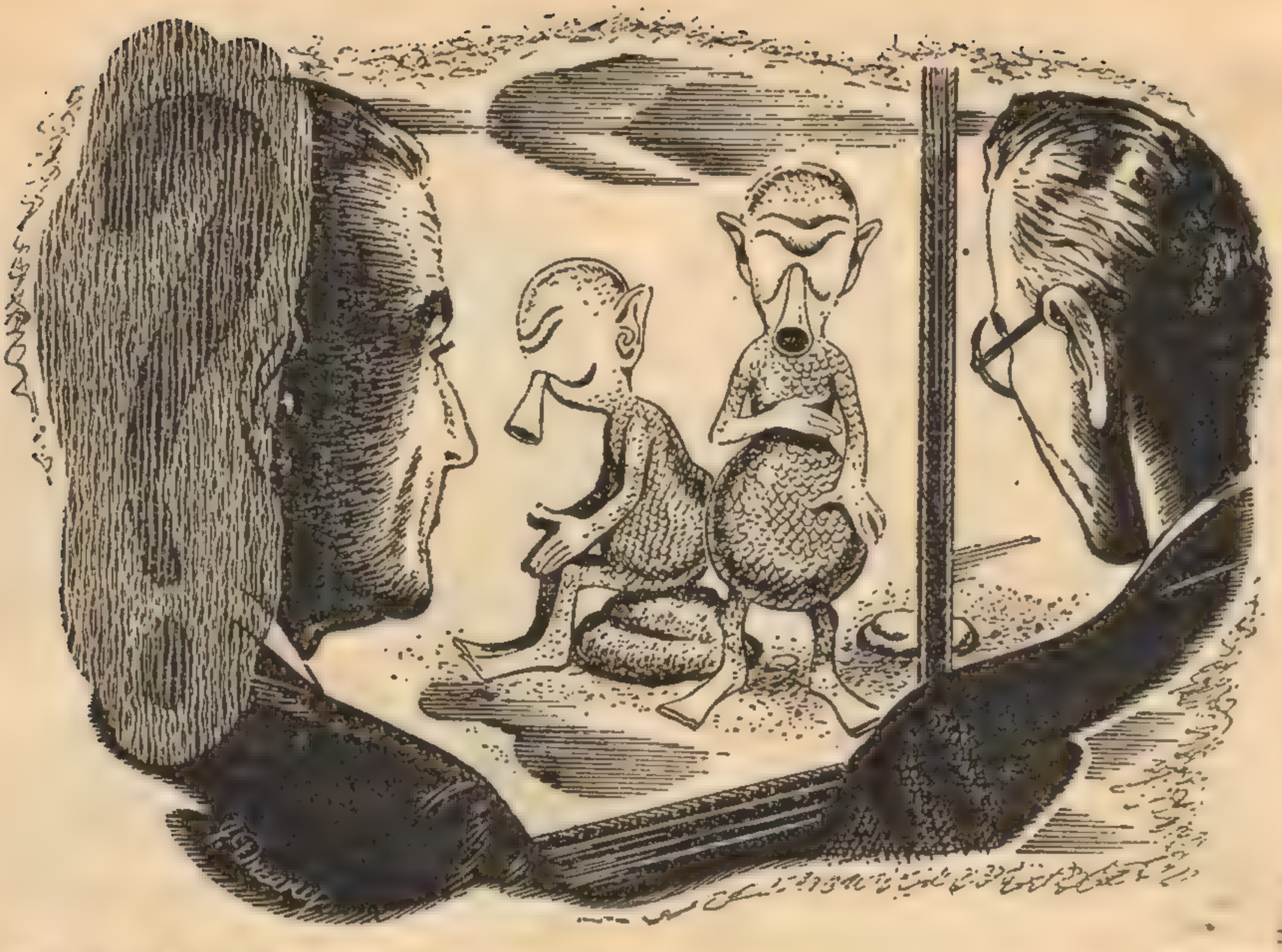
Garver vaguely remembered the words written by another man in another century:

". . . And all I ask is a tall ship, and a star to steer her by . . ."

He had his ship and he had all the stars in the universe shining through that porthole as the *Fafnir* reached cut-off.

In every age, in every time, there have been those who are not content to settle down. They miss the kick of the wheel, the wail of the wind in the rigging, the exotic sights and smells of a harbor half across the world, the roar of engines cutting through the slipstream, and the powerful, body-shaking thunder of the jets. It is to these restless men with the wanderlust that the human race owes a priceless debt as the wanderers push the horizons out to the stars—

THE END



QUIZ GAME

By FRANK M. ROBINSON

If the Aliens *landed—a million mysteries might be solved. But—boil it all down; you have time for only one question. What's the question?*

Illustrated by Dreany

"WHAT do they look like, Dad?" Jimmy asked.

I finished spooning the gravy over the mashed potatoes and passed the plate down to him.

"They're a sort of light green," I said. "Light green, with small scales, and they're about the size of Spot."

Jimmy toyed with his vegetables for a moment. "Are they gonna conquer the world like the Martians on Captain Video?" From the look on his face I could tell that he didn't consider the possibility a calamity.

"No, Jimmy, they're not going to conquer the Earth. They're not an aggressive race."

He made a small swimming pool out of his potatoes and solemnly floated a raft of peas on top of the gravy. "You must have been pretty excited when they landed, huh, Dad?"

"You just buckle right down to eating, young man," Dot cut in, "and let the questions go until later. Your father's had a hard day."

"You can't expect people not to ask questions about it," I said.

"What does Mr. Pelloquin think about it?" she asked. Her face grew intent. "What do *you* think?"

I helped myself to another slice of meat loaf and tried to keep the enthusiasm out of my voice. "I don't

think Sam Pelloquin thinks anything at all about it," I said. "It's just another story to him. As for myself, I think we'll jump a hundred years ahead overnight."

"I bet old man Harris was surprised when the rocket crashed on his farm!"

"Jimmy," I said quietly, "what did your mother just tell you?"

His face disappeared behind a slice of bread and jam. "I forgot, Dad."

After dinner I went to the bedroom to get my brief case. I was searching the top of the bureau for my security badge when Dot came in from the kitchen, dish towel still in her hand.

"Out again?"

"Long hours, Dot, for me as well as the other professors at the university." I smiled. "I guess you can put me down as working the night shift now."

"You know I'm not complaining," she said.

I found the badge and pinned it on my suit coat, then checked the contents of my brief case.

"You have to go through a lot of red tape for Security, don't you?" She asked the question rather hesitantly.

I zipped the leather case shut and wondered what it was she was digging for.

"You know why," I said. "Since they come from a civilization a lot more advanced than our own, they must know a lot about science that we don't. Once we establish communication with them—find out their language—it's going to be one big quiz game. Naturally all the security is to see that we're the only ones who get the answers."

"I see," she said, staring absently at the towel in her hands.

"That wasn't what you wanted to know, was it?" I could almost guess what was coming now. And all it proved was that Dot was just as human as the few dozen others who had already asked me different versions of the same question.

She gave the towel a half angry flirt and lowered her voice to the conspiratorial whisper we always used when we didn't want Jimmy to hear.

"I know the background," she whispered. "There's going to be a lot of scientists asking a lot of questions. And they'll be getting the answers because those people are way ahead of us in just about everything, aren't they? They know all about science and they should know a lot about medicine, too, shouldn't they? You said they have the same basic metabolism that we have!"

I nodded and waited for her to continue.

"You know Irene has cancer," she said, taking the plunge. "Maybe they even know something about that!" Irene was Dot's sister, a case the doctors had labeled hopeless years ago.

I waited a moment before replying, hating to promise her what wasn't mine to promise.

"They probably do, Dot. I guess they'll be asked questions like that. There are some men at the University who would like to know the same thing—for personal reasons."

She kissed me good night at the door and held me for a moment. "You'll be right there to remind them," she said fiercely. "Don't forget!"

It had started to rain a little, the drops slicking the front door stoop and making small haloes around the street lamps. I fumbled in my pockets for the car keys and just for a second glanced up at the black sky.

The aliens had come from some place up there, I thought. Strange little creatures from an unknown world who probably knew all the

answers to questions like Dot's—if we only knew how to ask them.

I drove along a side street to the Outer Drive, then relaxed in the seat, watching the shadowy trees and the misty street lamps slide quickly by. It had started, I thought, like any other item in what newspapermen call the "silly season," that part of the summer when the nation's press services are cluttered with reports of flying saucers, pink rains, and other unlikely events, the time of year when the Loch Ness sea monster gets its usual play.

There had been the unconfirmed story of the landing of the rocket in Indiana; an account where Sid Harris, the farmer on whose south forty the rocket had landed, was painted as pretty much of a Hoosier hick.

But the next story gave a somewhat different view of Harris. After all, you couldn't laugh off the solid evidence of seventy feet of gleaming, tubular rocket.

The government and the university arrived on the scene at just about the same time and when everything was said and done, the government had full charge of the rocket and the little men on board ended up in a special laboratory on the second floor of the Memorial Hall of Chemistry.

The creatures were friendly, they were not the forerunners of some other-world invasion a la Orson Welles, and they were highly intelligent. A press release on the latter, coupled with some remarks on the discoveries we would naturally make after we had poked around the inside of their rocket, started the next phase. It was only natural to speculate that if we could find out a lot from the rocket, how much more could we find out from the little men themselves? What if *we* knew what *they* knew!

And if we did? Well, in the books they call it Utopia or the Millennium.

The idea took hold. I liked it myself, even if I sometimes thought it was too good to be true, like Christmas Day every day from a kid's viewpoint or finding a million dollars on a street corner from my own.

You couldn't get around it. They probably knew the answers to everything we wanted to know.

The fissioning of light elements—
Cheap atomic power—
Maybe even cures for
Cancer—
Cerebral palsy—
Heart trouble—
Or how to live to be a hundred.
All we had to do was ask.

I checked in at the Administration Building first to see if there had been any calls or late afternoon mail for me.

"There's a Mr. Pelloquin waiting to see you, Professor Fenton," the receptionist said. "From the *Press*."

He was seated in a chair in a little nook off the main reception room. He was a big, solid man, slightly balding at the temples, with a passion for trench coats and battered hats that served almost as a trademark.

"Sorry, Sam," I said. "I didn't see you."

He brushed aside the apology, shook hands, and said: "Anything new on your little green men?"

"I'm on the night shift now," I said. "I've been away all day. Maybe you can tell me."

He waved some papers in his hand. "The usual deadly dull government releases. Interviews with people who saw 'the flash in the sky.' They don't stretch very far."

"Getting tired of it?"

He shook his head. "No. They're easy to cover and the way it looks, they're going to be good copy for a long time. Like when the quintuplets were born—I think there was a story

about them every day for a couple of years."

"Bigger stories will probably come along."

"The only stories that will be any bigger," he said pointedly, "are those that you probably won't be around to read about and I won't be around to cover."

"Sam," I said suddenly, "if you were going to ask them questions, what would *you* ask?"

A gleam came into his eyes. "They elected you for the job, eh?"

"Uh huh."

He closed his eyes in thought. "If they're so far ahead of us," he said after a moment, "then they must be a lot older race than we are, granted?"

I nodded.

"Then maybe it's just possible that they learned how to live with each other. I think if I were putting the questions to them, I would give them a briefing on the history of the human race and then ask them how we could live in peace for a change."

I had underestimated Sam, I thought, a little embarrassed.

"I'll buy that," I said.

He smiled. "But there are a few little items on fissionable isotopes that will probably come first, aren't there?" He glanced at his watch. "We've just got time for a short one for your brave new world, Dr. Fenton." For a moment he looked as wistful as a big man ever can. "Maybe this time it's the sure enough real McCoy. Maybe tomorrow starts a brand-new page."

I had just picked up my hat when the phone rang on the receptionist's desk. She was out at the moment and Sam answered it. I watched his face gray.

"For you?" I asked, when he had hung up.

He shook his head. "No, for you."

"Bad news?"

"I think we better walk over to Chemistry Hall right away. That was your secretary."

I felt a knot growing in my stomach. "Did she say what was wrong?"

"Yes," Sam said slowly. "I'm afraid your specimens are sick."

The university midway was a blaze of lights, the beams picking out the soldiers in wet raincoats and the hastily erected tents, glistening in the downpour, guarding the Chemistry Building. I doubted that anything had been released yet but you could sense something was wrong. There was a new tenseness and the checks and double checks before Sam and I were allowed to go in were more thorough and time-consuming than usual.

Miss Chandler, my secretary, was waiting in my office. She fingered some papers gingerly and held them out to me. "The latest reports."

I read through them hastily, then dropped them on my desk.

"What's wrong?" Sam asked.

"I'm not sure," I said. "Probably a pathogenic allergy of some kind, we don't know what."

"Like what wiped out the Martians in the Wells' story."

"What? Oh, yes. I suppose you could make a comparison."

"Think it will be fatal?"

I shrugged. "There's no way of knowing. Probably not. The number of people who die compared to those who get sick is always small. I know that's an analogy, of course, but I don't see why it wouldn't apply."

I was trying to be reassuring but I could see in his face that I wasn't succeeding.

"Would you like to see them? They've been declassified to that extent." He started to fumble for his camera but I stopped him. "Sorry, no cameras. The flash bulbs annoy them.

The halls were busier now than they

had been when we first came in. Security guards lined the corridors while grim-looking army officers and harried technicians in laboratory smocks hurried past them.

The room where the aliens were kept was a glassed-in, reconverted laboratory with only a dim, frosted bulb for illumination. We could make out a cluster of people in front of the glassed-in enclosure and soldiers at military ease along the wall. When our eyes had adjusted to the gloom, we joined the small crowd in front of the glass.

Sam had seen the few photographs that had been released but I knew that hadn't prepared him for the real thing. The room behind the glass had a sand floor with little cots of foam rubber spotted about and, in one corner, a small pool of water. The creatures standing by the pool were small and anthropomorphic in shape, a light emerald green in color, and with the same scales that I had mentioned to Jimmy. What the photographs never showed very clearly was their finely developed hands and the intelligent cast to their vaguely human faces.

"They're not as lively as they once were," I said, keeping my voice low. "They're listless and they won't take nourishment. The water doesn't interest them as much as it did, either."

He couldn't tear his eyes away. "Does anybody know where they come from?"

"As far as we can figure out, from some system in the general direction of Canopus—but how far, we don't know."

He stared through the glass a moment longer. "Nobody knows for sure just how long they'll last, do they?"

"Oh, I don't think it's too serious," I said, without conviction. "A reaction like this is almost to be expected. It could take a turn for the worst, of course, but I don't think that will happen." I wished that I could disguise my feelings better; he could probably tell from the tone of my voice that I was whistling in the dark.

"How's the problem of communication going?"

"It may be a few hours, it may be a few days, but it won't be much longer before we have the key to their language. It's much simpler than trying to decipher a dead language, by the way." I paused. "You know," I mused, "I sometimes get the impression that they're trying just as desperately hard to communicate with us as we are with them."

We withdrew to an anteroom and Sam made himself comfortable on a peeling, leather upholstered couch. I kept a weather eye on the worried looking visitors to the room beyond.

"Supposing," Sam started, trying to frame what he had in mind, "just supposing that they died. Would that make their trip here a total loss as far as we're concerned? Couldn't you get something of value from going over their ship?"

I shook my head. "I doubt it, newspaper stories to the contrary. Their machinery is a thousand years too advanced for us. It would be like Galileo trying to find out what makes a modern motor generator tick. We'll have to learn to talk to them before we find out much."

"And there's a possibility you'll never get that chance, isn't there?" he asked reluctantly.

"Don't needle me for news, Sam," I said in a tired voice. "I've told you all I can. The worst it could come to would be a race between our solving the riddle of their language and the disease, or whatever it is, killing them off. It's a race I think we could win in plenty of time."

He changed the subject. "Are you the only one that's going to ask them questions?"

"I'm the only one who will talk to them initially, and it's been left to my discretion exactly what we ask them at first. However, there's a committee working on a list of potential questions. I'll probably draw the ones I ask from it."

"Did you have anything specific in mind?"

I hesitated a moment. "You understand that the exact line of questioning is classified but I can give you a general hint. There are some questions we'd like to ask about the fissioning of light elements and there are some about radioactivity and fuels and fuel consumption figures for rockets. That type of knowledge is probably elementary to them. There are a few I'd like to ask myself about crystal structure and atomic theory, but it'll be a while before I get in my innings."

"How about the social sciences?"

I gave him a thoughtful look. "I think I know what you're driving at," I said dryly. "We'd like to ask a lot about government and psychology and medicine. We're not just thinking of the next one after the H-bomb."

"I wasn't worried about it," he said quietly. "But I'm glad you told me just the same."

Miss Chandler came in with another set of reports and I skimmed through them with a sinking heart.

Dot wanted me to ask the aliens about a cure for cancer.

Sam wanted a formula for peace.

My own committee, I knew, was primarily interested in the answers to questions that would take researchers years to find on their own.

But somebody was going to be left out; the potential list of questions had just grown suddenly shorter.

I looked up at Sam's questioning face and tried to keep my voice from shaking.

"The aliens are dying."

There wasn't much to do the next few hours. Sam telephoned in a few leads and then both of us spent the later hours chain-smoking in the anteroom and watching a dream slowly crumble. The dream grew a little more tattered, a little more tenuous with every worried face that disappeared into the room beyond and came out looking even more worried. Their expressions were more accurate than the calibrations on a fever thermometer.

"Just how bad off are they?" Sam finally asked.

I ran my hand across the faint stubble on my chin. "They'll be gone by morning."

I was too tired to even feel a reaction to my own admission. The dream was almost ended. The millennium would take a millennium and utopia was still something you wrote books about. People would die of cancer and there would still be wars and scientists would still spend agonizing years tracking down elementary facts.

"You know," Sam said, "when I was small, I used to ask my folks a lot of questions. And when I had stumped them, I hoped that some day I would run into somebody who knew all the answers. I think, in a way, all of us are like that. We all hope that some day we'll run into somebody who can tell us anything we want to know."

"We almost did," I said.

"It's going to be a big disappointment to everybody," he continued. "I think almost everybody was hoping for something from this. Something that would make life a little easier, a little better for them."

I knew what he meant.

"There isn't any hope of getting anything from them, huh?"

I ground my cigarette butt out

against my heel and dropped the slight wad of paper on the floor. "Well, maybe, but it would be a mighty long chance. If we could crack their language within the next few hours, we still might have some time. But the odds against it are high. We have no Rosetta stone, so to speak, for their spoken language. And in any case we wouldn't pass from ignorance to complete understanding just like that." I paused. "Even if it happened, our time would be extremely limited. A lot of important questions would have to be lopped off the list."

"The ones you wanted to ask on crystal structure, I suppose."

I smiled a little weakly. "Those, and a lot of more important ones. We've already dropped questions concerning atomic fission."

He looked surprised. "You're really narrowing the list, aren't you?"

"We haven't much time," I said. "There are a lot of things we'd like to know about, a lot of things that are quite important. Sociological questions, questions about disease, items of that nature."

"Considering how different they are," he asked, curious, "what good would it do to ask them questions about government, let's say, or something like cancer cures?"

"It's not the differences that are important," I said, "it's the similarities. They got here in a rocket, which implies a technology, which in turn implies a government of some sort. You have to extrapolate from there. Since their science is more advanced than ours, you assume it's older and that, in turn, their experience with governmental systems is older and greater than our own. As for diseases, they're oxygen breathing animals a great deal like ourselves; it's not too farfetched that there may be some diseases or organic failure common to both of us."

"I get you."

I stood up and walked over to the window that opened out on the midway. A crowd had started to gather some hours ago and the midway and the streets were black with them now.

I ran my finger around the inside of my collar, separating the damp cloth from my sweaty neck.

If it came to where I only had a chance to ask a few questions, I thought, what would they be? What would *they* ask, down there?

How to cure disease?

How to live to be a hundred?

How to be happy?

I wished I knew.

It was five in the morning when Hary Weber, city editor at the *Press*, came in. I had met him once before; a grim, efficient man whose sole interest in Armageddon would be its proper story coverage.

"You shouldn't have bothered coming," I said. "There isn't going to be anything worth writing about."

He threw his raincoat on the couch, where the water ran off and formed puddles on the leather.

"I always cover disasters," he said.

"Disasters?"

"That's what this is, isn't it?"

"Yes," I said, "I guess it is."

"Are they gone?"

"No. Not yet."

"They'll be dead shortly," Sam said. "Utopia's going up in smoke."

I was tired and edgy. "So far," I said deliberately, "we've been pretty selfish about this, haven't we? Did you ever wonder what it's like for *them*, what *they're* thinking of for a change?"

Weber stared at me blankly and then Sam said: "It must be hell to die so far away from home."

We settled back into a gloomy silence and I lost myself watching the drops slowly run off Weber's raincoat. Another half hour had gone by when

a lab man looked in and said: "We've broken the language, Dr. Fenton."

I didn't even look up. "Does it matter any more?"

"Dr. Crooks says the aliens are still alive, sir."

I stood up, my tiredness dropping away like a discarded shirt. We had won, I thought. Just how much remained to be seen. But we had won —at least a little.

I walked into the room where the aliens were waiting.

Sam and Weber were at the window watching the sun come up when I came back in. They didn't hear me.

"Our big worry now is how we're going to fake a story so the wind-up won't sound as bad as it is," Weber was saying. "After all, you just don't shoot Santa Claus."

"Oh, we'll find a way," Sam said brutally.

I made a noise and they turned and saw me.

Sam glanced at me soberly and said: "I can read it in your face. They died before you could even ask them their names."

"No," I said, "no, they didn't. We had time to talk to them."

My eyes were having difficulty focusing after the gloom of the next room.

"There were only two left," I continued.

Weber had his notebook out. "What did you ask them?"

"You know," I mused, "it was wonderful to be able to lean on somebody for a while. To think that there were beings who could answer all our questions." I stopped a minute and fumbled for my glasses. "And maybe that's what they were thinking, too."

"The questions?" Sam repeated.

I felt like I wanted to be quietly sick.

"We winnowed the questions out pretty well. We discarded most of the scientific questions—we'll find the answers to them eventually. The same with the sociological. What we wanted to ask was something—something fundamental."

I felt myself wandering again. "I think we made the wrong assumption. How do you tell whether a civilization is inferior or superior? Because they had the means to get here didn't mean that the aliens considered themselves superior to us. Would another race judge superiority the same way we do?

They couldn't see what I was driving at. "What did you ask?" Weber repeated.

I made a conscious effort to get a grip on myself. "I thought I had winnowed the questions down pretty well. Maybe somebody else would have thought of different questions, I don't know. But the questions I was going to ask actually don't matter."

Both of them caught it at the same time. "Going to?" Sam asked stupidly.

"Oh, don't you see!" I shouted. "What do you think they landed *here* for, why do you think they tried so hard to communicate with us, trying to make themselves understood? Can't you guess what happened in the short time we had before they died?

"We didn't get a chance to ask them anything! *They* asked *us!*"

IMPOSTOR

By PHILIP K. DICK

If it were known that The Enemy could manufacture a letter-perfect duplicate of a man—how could you prove you were yourself?

"ONE of these days I'm going to take time off," Spence Olham said at first-meal. He looked around at his wife. "I think I've earned a rest. Ten years is a long time."

"And the Project?"

"The war will be won without me. This ball of clay of ours isn't really in much danger." Olham sat down at the table and lit a cigarette. "The newsmachines alter dispatches to make it appear the Outspacers are right on top of us. You know what I'd like to do on my vacation? I'd like to take a camping trip in those mountains outside of town, where we went that time. Remember? I got poison oak and you almost stepped on a gopher snake."

"Sutton Wood?" Mary began to clear away the food dishes. "The Wood was burned a few weeks ago. I thought you knew. Some kind of a flash fire."

Olham sagged. "Didn't they even try to find the cause?" His lips twisted. "No one cares any more. All they can think of is the war." He clamped his jaws together, the whole picture coming up in his mind, the Outspacers, the war, the needle ships.

"How can we think about anything else?"

Olham nodded. She was right, of course. The dark little ships out of Alpha Centauri had by-passed the Earth cruisers easily, leaving them like helpless turtles. It had been one-way fights, all the way back to Terra.

All the way, until the protec-bubble was demonstrated by Westinghouse Labs. Thrown around the major Earth cities and finally the planet itself, the bubble was the first real defense, the first legitimate answer to the Outspacers—as the newsmachines labeled them.

But to win the war, that was another thing. Every lab, every project was working night and day, endlessly, to find something more: a weapon for positive combat. His own project, for example. All day long, year after year.

Olham stood up, putting out his cigarette. "Like the Sword of Damocles. Always hanging over us. I'm getting tired. All I want to do is take a long rest. But I guess everybody feels that way."

He got his jacket from the closet and went out on the front porch. The shoot would be along any moment, the fast little bug that would carry him to the Project.

"I hope Nelson isn't late." He looked at his watch. "It's almost seven."

"Here the bug comes," Mary said, gazing between the rows of houses. The sun glittered behind the roofs, reflecting against the heavy lead plates. The settlement was quiet; only a few people were stirring. "I'll see

you later. Try not to work beyond your shift, Spence."

Olham opened the car door and slid inside, leaning back against the seat with a sigh. There was an older man with Nelson.

"Well?" Olham said, as the bug shot ahead. "Heard any interesting news?"

"The usual," Nelson said. "A few Outspace ships hit, another asteroid abandoned for strategic reasons."

"It'll be good when we get the Project into final stage. Maybe it's just the propaganda from the news-machines, but in the last month I've gotten weary of all this. Everything seems so grim and serious, no color to life."

"Do you think the war is in vain?" the older man said suddenly. "You are an integral part of it, yourself."

"This is Major Peters," Nelson said. Olham and Peters shook hands. Olham studied the older man.

"What brings you along so early?" he said. "I don't remember seeing you at the Project before."

"No, I'm not with the Project," Peters said, "but I know something about what you're doing. My own work is altogether different."

A look passed between him and Nelson. Olham noticed it and he frowned. The bug was gaining speed, flashing across the barren, lifeless ground toward the distant rim of the Project buildings.

"What is your business?" Olham said. "Or aren't you permitted to talk about it?"

"I'm with the government," Peters said. "With FSA, the Security Organ."

"Oh?" Olham raised an eyebrow. "Is there any enemy infiltration in this region?"

"As a matter of fact I'm here to see you, Mr. Olham."

Olham was puzzled. He considered Peters' words, but he could make nothing of them. "To see me? Why?"

"I'm here to arrest you as an Outspace spy. That's why I'm up so early this morning. *Grab him, Nelson*—"

The gun drove into Olham's ribs. Nelson's hands were shaking, trembling with released emotion, his face pale. He took a deep breath and let it out again.

"Shall we kill him now?" he whispered to Peters. "I think we should kill him now. We can't wait."

Olham stared into his friend's face. He opened his mouth to speak, but no words came. Both men were staring at him steadily, rigid and grim with fright. Olham felt dizzy. His head ached and spun.

"I don't understand," he murmured.

At that moment the shoot car left the ground and rushed up, heading into space. Below them the Project fell away, smaller and smaller, disappearing. Olham shut his mouth.

"We can wait a little," Peters said. "I want to ask him some questions, first."

Olham gazed dully ahead as the bug rushed through space.

"The arrest was made all right," Peters said into the vidscreen. On the screen the features of the Security chief showed. "It should be a load off everyone's mind."

"Any complications?"

"None. He entered the bug without suspicion. He didn't seem to think my presence was too unusual."

"Where are you now?"

"On our way out, just inside the protec-bubble. We're moving at maximum speed. You can assume that the critical period is past. I'm glad the take-off jets in this craft were in good working order. If there had been any failure at that point—"

"Let me see him," the Security chief said. He gazed directly at Olham where he sat, his hands in his lap, staring ahead.

"So that's the man." He looked at Olham for a time. Olham said nothing. At last the chief nodded to Peters. "All right. That's enough." A faint trace of disgust wrinkled his features. "I've seen all I want. You've done something that will be remembered for a long time. They're preparing some sort of citation for both of you."

"That's not necessary," Peters said. "How much danger is there now? Is there still much chance that—"

"There is some chance, but not too much. According to my understanding, it requires a verbal key phrase. In any case we'll have to take the risk."

"I'll have the Moon base notified you're coming."

"No," Peters shook his head. "I'll land the ship outside, beyond the base. I don't want it in jeopardy."

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"Just as you like." The chief's eyes flickered as he glanced again at Olham. Then his image faded. The screen blanked.

Olham shifted his gaze to the window. The ship was already through the protec-bubble, rushing with greater and greater speed all the time. Peters was in a hurry; below him, rumbling under the floor, the jets were wide open. They were afraid, hurrying frantically, because of him.

Next to him on the seat, Nelson shifted uneasily. "I think we should do it now," he said. "I'd give anything if we could get it over with."

"Take it easy," Peters said. "I want you to guide the ship for a while so I can talk to him."

He slid over beside Olham, looking into his face. Presently he reached out and touched him gingerly, on the arm and then on the cheek.

Olham said nothing. *If I could let Mary know*, he thought again. *If I could find some way of letting her know.* He looked around the ship. How? The vidscreen? Nelson was sitting by the board, holding the gun. There was nothing he could do. He was caught, trapped.

But why?

"Listen," Peters said. "I want to ask you some questions. You know where we're going. We're moving Moonward. In an hour we'll land on the far side, on the desolate side. After we land you'll be turned over immediately to a team of men waiting there. Your body will be destroyed at once. Do you understand that?" He looked at his watch. "Within two hours your parts will be strewn over the landscape. There won't be anything left of you."

Olham struggled out of his lethargy. "Can't you tell me—"

"Certainly, I'll tell you." Peters nodded. "Two days ago we received

a report that an Outspace ship had penetrated the protec-bubble. The ship let off a spy in the form of a humanoid robot. The robot was to destroy a particular human being and take his place."

Peters looked calmly at Olham.

"Inside the robot was a U-bomb. Our agent did not know how the bomb was to be detonated, but he conjectured that it might be by a particular spoken phrase, a certain group of words. The robot would live the life of the person he killed, entering into his usual activities, his job, his social life. He had been constructed to resemble that person. No one would know the difference."

Olham's face went sickly chalk.

"The person whom the robot was to impersonate was Spence Olham, a high-ranking official at one of the Research projects. Because this particular project was approaching crucial stage, the presence of an animate bomb, moving toward the center of the Project—"

Olham stared down at his hands. "*But I'm Olham!*"

"Once the robot had located and killed Olham, it was a simple matter to take over his life. The robot was probably released from the ship eight days ago. The substitution was probably accomplished over the last week end, when Olham went for a short walk in the hills."

"But I'm Olham." He turned to Nelson, sitting at the controls. "Don't you recognize me? You've known me for twenty years. Don't you remember how we went to college together?" He stood up. "You and I were at the University. We had the same room." He went toward Nelson.

"Stay away from me!" Nelson snarled.

"Listen. Remember our second year? Remember that girl. What was her name—" He rubbed his forehead. "The one with the dark hair. The one we met over at Ted's place."

"Stop!" Nelson waved the gun frantically. "I don't want to hear any more. You killed him! You . . . machine."

Olham looked at Nelson. "You're wrong. I don't know what happened, but the robot never reached me. Something must have gone wrong. Maybe the ship crashed." He turned to Peters. "I'm Olham. I know it. No transfer was made. I'm the same as I've always been."

He touched himself, running his hands over his body. "There must be some way to prove it. Take me back to Earth. An X-ray examination, a neurological study, anything like that will show you. Or maybe we can find the crashed ship."

Neither Peters nor Nelson spoke.

"I am Olham," he said again. "I know I am. But I can't prove it."

"The robot," Peters said, "wou be unaware that he was not the real Spence Olham. He would become Olham in mind as well as in body. He was given an artificial memory system, false recall. He would look like him, have his memories, his thoughts and interests, perform his job.

"But there would be one difference. Inside the robot is a U-bomb, ready to explode at the trigger phrase." Peters moved a little away. "That's the one difference. That's why we're taking you to the Moon. They'll disassemble you and remove the bomb. Maybe it will explode, but it won't matter, not there."

Olham sat down slowly.

"We'll be there soon," Nelson said.

He lay back, thinking frantically, as the ship dropped slowly down. Under them was the pitted surface of the Moon, the endless expanse of ruin. What could he do? What would save him?"

"Get ready," Peters said.

In a few minutes he would be dead. Down below he could see a tiny dot, a building of some kind. There were men in the building, the demolition team, waiting to tear him to bits. They would rip him open, pull off his arms and legs, break him apart. When they found no bomb they would be surprised; they would know, but it would be too late.

Olham looked around the small cabin. Nelson was still holding the gun. There was no chance there. If he could get to a doctor, have an examination made—that was the only way. Mary could help him. He thought frantically, his mind racing. Only a few minutes, just a little time left. If he could contact her, get word to her some way.

"Easy," Peters said. The ship came down slowly, bumping on the rough ground. There was silence.

"Listen," Olham said thickly. "I can prove I'm Spence Olham. Get a doctor. Bring him here—"

"There's the squad." Nelson pointed. "They're coming." He glanced nervously at Olham. "I hope nothing happens."

"We'll be gone before they start work," Peters said. "We'll be out of here in a moment." He put on his pressure suit. When he had finished he took the gun from Nelson. "I'll watch him for a moment."

Nelson put on his pressure suit, hurrying awkwardly. "How about him?" He indicated Olham. "Will he need one?"

"No." Peters shook his head. "Robots probably don't require oxygen."

The group of men were almost to the ship. They halted, waiting. Peters signaled to them.

"Come on!" He waved his hand and the men approached warily; stiff, grotesque figures in their inflated suits.

"If you open the door," Olham said, "it means my death. It will be murder."

"Open the door," Nelson said. He reached for the handle.

Olham watched him. He saw the man's hand tighten around the metal rod. In a moment the door would swing back, the air in the ship would rush out. He would die, and presently they would realize their mistake. Perhaps at some other time, when there was no war, men might not act this way, hurrying an individual to his death because they were afraid. Everyone was frightened, everyone was willing to sacrifice the individual because of the group fear.

He was being killed because they could not wait to be sure of his guilt. There was not enough time.

He looked at Nelson. Nelson had been his friend for years. They had gone to school together. He had been best man at his wedding. Now Nelson was going to kill him. But Nelson was not wicked; it was not his fault. It was the times. Perhaps it had been the same way during the plagues. When men had shown a spot they probably had been killed, too, without a moment's hesitation, without proof, on suspicion alone. In times of danger there was no other way.

He did not blame them. But he had to live. His life was too precious to be sacrificed. Olham thought quickly. What could he do? Was there anything? He looked around.

"Here goes," Nelson said.

"You're right," Olham said. The sound of his own voice surprised him. It was the strength of desperation. "I have no need of air. Open the door."

They paused, looking at him in curious alarm.

"Go ahead. Open it. It makes no difference." Olham's hand disappeared

inside his jacket. "I wonder how far you two can run."

"Run?"

"You have fifteen seconds to live." Inside his jacket his fingers twisted, his arm suddenly rigid. He relaxed, smiling a little. "You were wrong about the trigger phrase. In that respect you were mistaken. Fourteen seconds, now."

Two shocked faces stared at him from the pressure suits. Then they were struggling, running, tearing the door open. The air shrieked out, spilling into the void. Peters and Nelson bolted out of the ship. Olham came after them. He grasped the door and dragged it shut. The automatic pressure system chugged furiously, restoring the air. Olham let his breath out with a shudder.

One more second—

Beyond the window the two men had joined the group. The group scattered, running in all directions. One by one they threw themselves down, prone on the ground. Olham seated himself at the control board. He moved the dials into place. As the ship rose up into the air the men below scrambled to their feet and stared up, their mouths open.

"Sorry," Olham murmured, "but I've got to get back to Earth."

He headed the ship back the way it had come.

It was night. All around the ship crickets chirped, disturbing the chill darkness. Olham bent over the vid-screen. Gradually the image formed; the call had gone through without trouble. He breathed a sigh of relief.

"Mary," he said. The woman stared at him. She gasped.

"Spence! Where are you? What's happened?"

"I can't tell you. Listen, I have to talk fast. They may break this call off any minute. Go to the Project grounds and get Dr. Chamberlain. If he isn't there, get any doctor. Bring him to the house and have him stay there. Have him bring equipment, X-ray, fluoroscope, everything."

"But—"

"Do as I say. Hurry. Have him get it ready in an hour." Olham leaned toward the screen. "Is everything all right? Are you alone?"

"Alone?"

"Is anyone with you? Has . . . has Nelson or anyone contacted you?"

"No, Spence, I don't understand."

"All right. I'll see you at the house in an hour. And don't tell anyone anything. Get Chamberlain there on any pretext. Say you're very ill."

He broke the connection and looked at his watch. A moment later he left the ship, stepping down into the darkness. He had a half mile to go.

He began to walk.

One light showed in the window, the study light. He watched it, kneeling against the fence. There was no sound, no movement of any kind. He held his watch up and read it by starlight. Almost an hour had passed.

Along the street a shoot bug came. It went on.

Olham looked toward the house. The doctor should have already come. He should be inside, waiting with Mary. A thought struck him. Had she been able to leave the house? Perhaps they had intercepted her. Maybe he was moving into a trap.

But what else could he do?

With a doctor's records, photographs and reports, there was a chance, a chance of proof. If he could be examined, if he could remain alive long enough for them to study him—

He could prove it that way. It was probably the only way. His one hope lay inside the house. Dr. Chamberlain was a respected man. He was the staff doctor for the Project. He would

know; his word on the matter would have meaning. He could overcome their hysteria, their madness, with facts.

Madness—That was what it was. If only they could wait, act slowly, take their time. But they could not wait. He had to die, die at once, without proof, without any kind of trial, or examination. The simplest test would tell, but they had not time for the simplest test. They could think only of the danger. Danger, and nothing more.

He stood up and moved toward the house. He came up on the porch. At the door he paused, listening. Still no sound. The house was absolutely still.

Too still.

Olham stood on the porch, unmoving. They were trying to be silent inside. Why? It was a small house; only a few feet away, beyond the door, Mary and Dr. Chamberlain should be standing. Yet he could hear nothing, no sound of voices, nothing at all. He looked at the door. It was a door he had opened and closed a thousand times, every morning and every night.

He put his hand on the knob. Then, all at once, he reached out and touched the bell instead. The bell pealed, off some place in the back of the house. Olham smiled. He could hear movement.

Mary opened the door. As soon as he saw her face he knew.

He ran, throwing himself into the bushes. A Security officer shoved Mary out of way, firing past her. The bushes burst apart. Olham wriggled around the side of the house. He leaped up and ran, racing frantically into the darkness. A searchlight snapped on, a beam of light circling past him.

He crossed the road and squeezed over a fence. He jumped down and made his way across a backyard. Behind him men were coming, Security officers, shouting to each other as they came. Olham gasped for breath, his chest rising and falling.

Her face—He had known at once. The set lips, the terrified, wretched eyes. Suppose he had gone ahead, pushed open the door and entered! They had tapped the call and come at once, as soon as he had broken off. Probably she believed their account. No doubt she thought he was the robot, too.

Olham ran on and on. He was losing the officers, dropping them behind. Apparently they were not much good at running. He climbed a hill and made his way down the other side. In a moment he would be back at the ship. But where to, this time? He slowed down, stopping. He could see the ship already, outlined against the sky, where he had parked it. The settlement was behind him; he was on the outskirts of the wilderness between the inhabited places, where the forests and desolation began. He crossed a barren field and entered the trees.

As he came toward it, the door of the ship opened.

Peters stepped out, framed against the light. In his arms was a heavy boris-gun. Olham stopped, rigid. Peters stared around him, into the darkness. "I know you're there, some place," he said. "Come on up here, Olham. There are Security men all around you."

Olham did not move.

"Listen to me. We will catch you very shortly. Apparently you still do not believe you're the robot. Your call to the woman indicates that you are still under the illusion created by your artificial memories.

"But you *are* the robot. You are the robot, and inside you is the bomb. Any moment the trigger phrase may be spoken, by you, by someone else, by anyone. When that happens the

bomb will destroy everything for miles around. The Project, the woman, all of us will be killed. Do you understand?"

Olham said nothing. He was listening. Men were moving toward him, slipping through the woods.

"If you don't come out, we'll catch you. It will be only a matter of time. We no longer plan to remove you to the Moon-base. You will be destroyed on sight and we will have to take the chance that the bomb will detonate. I have ordered every available Security officer into the area. The whole county is being searched, inch by inch. There is no place you can go. Around this wood is a cordon of armed men. You have about six hours left before the last inch is covered."

Olham moved away. Peters went on speaking; he had not seen him at all. It was too dark to see anyone. But Peters was right. There was no place he could go. He was beyond the settlement, on the outskirts where the woods began. He could hide for a time, but eventually they would catch him.

Only a matter of time.

Olham walked quietly through the wood. Mile by mile, each part of the county was being measured off, laid bare, searched, studied, examined. The cordon was coming all the time, squeezing him into a smaller and smaller space.

What was there left? He had lost the ship, the one hope of escape. They were at his home; his wife was with them, believing, no doubt, that the real Olham had been killed. He clenched his fists. Some place there was a wrecked Outspace needle-ship, and in it the remains of the robot. Somewhere nearby the ship had crashed, crashed and broken up.

And the robot lay inside, destroyed.

A faint hope stirred him. What if he ould find the remains? If he could show them the wreckage, the remains of the ship, the robot—

But where? Where would he find it?

He walked on, lost in thought. Some place, not too far off, probably. The ship would have landed close to the Project; the robot would have expected to go the rest of the way on foot. He went up the side of a hill and looked around. Crashed and burned. Was there some clue, some hint? Had he read anything, heard anything? Some place close by, within walking distance. Some wild place, a remote spot where there would be no people.

Suddenly Olham smiled. Crashed and burned—

Sutton Wood.

He increased his pace.

It was morning. Sunlight filtered down through the broken trees, onto the man crouching at the edge of the clearing. Olham glanced up from time to time, listening. They were not far off, only a few minutes away. He smiled.

Down below him, strewn across the clearing and into the charred stumps that had been Sutton Wood, lay a tangled mass of wreckage. In the sunlight it glittered a little, gleaming darkly. He had not had too much trouble finding it. Sutton Wood was a place he knew well; he had climbed around it many times in his life, when he was younger. He had known where he would find the remains. There was one peak that jutted up suddenly, without warning.

A descending ship, unfamiliar with the Wood, had little chance of missing it. And now he squatted, looking down at the ship, or what remained of it.

Olham stood up. He could hear them, only a little distance away, coming together, talking in low tones. He tensed himself. Everything depended on who first saw him. If it

were Nelson, he had no chance. Nelson would fire at once. He would be dead before they saw the ship. But if he had time to call out, hold them off for a moment—That was all he needed. Once they saw the ship he would be safe.

But if they fired first—

A charred branch cracked. A figure appeared, coming forward uncertainly. Olham took a deep breath. Only a few seconds remained, perhaps the last seconds in his life. He raised his arms, peering intently.

It was Peters.

"Peters!" Olham waved his arms. Peters lifted his gun, aiming. "Don't fire!" His voice shook. "Wait a minute. Look past me, across the clearing."

"I've found him," Peters shouted. Security men came pouring out of the burned woods around him.

"Don't shoot. Look past me. The ship, the needle-ship. The Outspace ship. Look!"

Peters hesitated. The gun wavered.

"It's down there," Olham said rapidly. "I knew I'd find it here. The burned wood. Now you believe me. You'll find the remains of the robot in the ship. Look, will you?"

"There is something down there," one of the men said nervously.

"Shoot him!" a voice said. It was Nelson.

"Wait." Peters turned sharply. "I'm in charge. Don't anyone fire. Maybe he's telling the truth."

"Shoot him," Nelson said. "He killed Olham. Any minute he may kill us all. If the bomb goes off—"

"Shut up." Peters advanced toward the slope. He stared down. "Look at that." He waved two men up to him. "Go down there and see what that is."

The men raced down the slope, across the clearing. They bent down, poking in the ruins of the ship.

"Well?" Peters called.

Olham held his breath. He smiled a little. It must be there; he had not had time to look, himself, but it had to be there. Suddenly doubt assailed him. Suppose the robot had lived long enough to wander away? Suppose his body had been completely destroyed, burned to ashes by the fire?

He licked his lips. Perspiration came out on his forehead. Nelson was staring at him, his face still livid. His chest rose and fell.

"Kill him," Nelson said. "Before he kills us."

The two men stood up.

"What have you found?" Peters said. He held the gun steady. "Is there anything there?"

"Looks like something. It's a needle-ship, all right. There's something beside it."

"I'll look." Peters strode past Olham. Olham watched him go down the hill and up to the men. The others were following after him, peering to see.

"It's a body of some sort," Peters said. "Look at it!"

Olham came along with them. They stood around in a circle, staring down.

On the ground, bent and twisted into a strange shape, was a grotesque form. It looked human, perhaps; except that it was bent so strangely, the arms and legs flung off in all directions. The mouth was open, the eyes stared glassily.

"Like a machine that's run down," Peters murmured.

Olham smiled feebly. "Well?" he said.

Peters looked at him. "I can't believe it. You were telling the truth all the time."

"The robot never reached me," Olham said. He took out a cigarette and lit it. "It was destroyed when the ship crashed. You were all too busy with the war to wonder why an out-

of-the-way woods would suddenly catch fire and burn. Now you know."

He stood smoking, watching the men. They were dragging the grotesque remains from the ship. The body was stiff, the arms and legs rigid.

"You'll find the bomb, now," Olham said. The men laid the body on the ground. Peters bent down.

"I think I see the corner of it." He reached out, touching the body.

The chest of the corpse had been laid open. Within the gaping tear something glinted, something metal. The men stared at the metal without speaking.

"That would have destroyed us all, if it had lived," Peters said. "That metal box, there."

There was silence.

"I think we owe you something," Peters said to Olham. "This must have been a nightmare to you. If you hadn't escaped, we would have—" He broke off.

Olham put out his cigarette. "I knew, of course, that the robot had never reached me. But I had no way of proving it. Sometimes it isn't possible to prove a thing right away. That was the whole trouble. There wasn't any way I could demonstrate that I was myself."

"How about a vacation?" Peters said. "I think we might work out a month's vacation for you. You could take it easy, relax."

"I think right now I want to go home," Olham said.

"All right, then," Peters said. "Whatever you say."

Nelson had squatted down on the ground, beside the corpse. He reached out toward the glint of metal visible within the chest.

"Don't touch it," Olham said. "It might still go off. We better let the demolition squad take care of it later on."

Nelson said nothing. Suddenly he grabbed hold of the metal, reaching his hand inside the chest. He pulled.

"What are you doing?" Olham cried.

Nelson stood up. He was holding onto the metal object. His face was blank with terror. It was a metal knife, an Outspace needle-knife, covered with blood.

"This killed him," Nelson whispered. "My friend was killed with this." He looked at Olham. "You killed him with this and left him beside the ship.

Olham was trembling. His teeth chattered. He looked from the knife to the body. "This can't be Olham," he said. His mind spun, everything was whirling. "Was I wrong?"

He gaped.

"But if that's Olham, then I must be—"

He did not complete the sentence, only the first phrase. The blast was visible all the way to Alpha Centauri.

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By P. SCHUYLER MILLER

"MODERN SCIENCE FICTION"

SCIENCE fiction, it is now generally agreed, is out of its childhood and well into an active adolescence, and as with most families the neighbors are beginning to talk. For a good many of the older generation, it's talk of the "I can't see *what* they see in him" variety; the younger set are pretty well divided. And then there are the articles about "the younger generation." (Last night the Pittsburgh Science Fiction Association was interrogated by an English major who hopes to get an "A" grade *and* a salable article out of something he'd heard about).

"Modern Science Fiction" (Coward-McCann, New York. 294 pp. $3.75) is a symposium on the present and probable future state of science fiction. "It's meaning and Its Future" is the subtitle. The book is edited by Reginald ("Gnurrs") Bretnor and it includes chapters by your editor, John Campbell, Anthony Boucher, Fletcher Pratt, L. Sprague de Camp, Isaac Asimov, Arthur C. Clarke, Philip Wylie, Gerald Heard and, perhaps less known, Don Fabun and Rosalie Moore. It contains some thought-provoking information and ideas, some of which we are going to discuss here and now. Others may get their innings later, and I'll be glad to have your comments, direct or in "Brass Tacks."

If you're not planning to own the book, it is one you can certainly recommend to your public library (and suggest that the librarians read themselves).

John Campbell's chapter, coming at the beginning, is mildly historical

and ties together many of the positive ideas he has expressed in his editorials here. Some quotes on points I particularly like:

"In science fiction, the reader can be freed of cultural fixations more than in any ordinary literature. Problems which can not be discussed in ordinary work can be brought forth in direct, clear consideration — as problems of the Martians and the Saggitarians."

"The culture we live in today accepts the need and the inevitability of change. But only gradually is it beginning to recognize, too, the vital necessity of discussing the nature of the changes that are desirable before making them and trying them out. . . . Science fiction can provide for a science-based culture . . . a means of practicing out in the no-practice area . . . If we fail to practice in imagination . . . we'll be back to the days of trial and error. But only for a little time; we've already done so much work that a few more trials and we'll hit the permanent error."

Anthony Boucher's section is to me one of the most interesting. Writer, critic, co-editor of the best fantasy *plus* science fiction magazine currently on the stands, he reports some thought-provoking facts about the economics of this "literature of the future." Boucher makes a point I've intended to use myself (and undoubtedly will yet), that sf—bookwise—now stands about where the detective story did twenty years ago, about the time when S. S. Van Dine seemed suddenly to make "whodunits" popular and respectable. But there are differences . . .

Mysteries, Boucher says, are dead within six weeks of publication: they, and their publishers and writers, rely on a reincarnation through paperback reprints to make ends meet. But science-fiction books go right on selling, smally but steadily, even after the paper reprint is out: they're what publishers call "permanent backlist items." As a result of this situation, Boucher predicts: an unspectacular niche for science-fiction books as a permanent part of regular publishing; a continuing hybridization of sf and mysteries; a switch to original sf novels instead of the current spate of anthologies and collections; an increase in the number of original paper-backs (and in their sexiness—on the cover, at least).

Don Fabun's chapter is largely a survey of what science fiction has done on the screen and the air, and what happened. He is not very hopeful for "real" science fiction in any of the three media, as high-popularity fare.

Arguments over "Modern Science Fiction" will center not on these orthodox and factual chapters, but on the last two-thirds of the book: the statements on science fiction's literary position and philosophical importance.

Fletcher Pratt, a critic of the most friendly, expands on what he has been saying in various prefaces such as that for "World of Wonder." Science fiction, he argues, needs to achieve more self-discipline—to do, in a word, what Heinlein does in his meticulously worked-out juveniles like "Farmer in the Sky": be consistent as to science —no impossibilities, unless you've set up the story on that proposition—plot—no contradictions and loose ends —and character — different people should *be* different people.

There are dissenters from this position, and Pratt gives them their due. He also has at the legitimate accusation that cultism and clichés ride sf too hard—van Vogtian mystification, the superman, the surprise ending, sequelizing. These gimmicks, used solely to trick and titillate the reader, nullify such claims as those John

Campbell made, that science fiction is a literature of intellectual and scientific exploration.

Much good science fiction—some would say most or all great science fiction—has been written by people in the "main stream" of literature, who did not label their stories sf. Orwell's "1984," Stapledon's "Last and First Men," Huxley's "Brave New World" and many, many short stories come in this category, which Rosalie Moore discusses. Science fiction, she points out, is currently more acceptable than fantasy, and "fancy"—a distinction which no one else has made, that I recall—is completely out of the running. But bewildered editors of mass-circulation magazines, deciding to experiment with this strange new stuff, seem to be prone to buy merely fanciful tales instead of good, red-blooded, venturesome science fiction or fantasy. Fancy, perhaps, is what was wrong with the old Merritt, Munsey school of fantasy and its imitators.

The very freedom of imagination and method which science fiction enjoys calls for greater skill in writing than comparable main-stream stories, Miss Moore suggests. Only in science fiction and fantasy, she says, have many experimental techniques in writing come through on a popular level. And only in science fiction does the writer seem to have freed himself from the main-stream despair and frustration with the realities of the world, in the conviction that man can make whatever worlds he wants—if only he will.

Sprague de Camp's chapter is basically one on the writing of science fiction—you are warned to watch for his "Rockets, Robots and Romance," a book on the subject which has just gone to the publisher. He warns would-be writers against some of the faults which previous contributors to the book have been pointing out. The value of this kind of writing, he maintains, is that it accustoms its readers to the idea of inevitable change and of a host of possible alternative outcomes to present tendencies. This kind of mental flexibility should help science fiction readers to cope with whatever contingencies do arise.

(Every contributor to the book, by the way, uses specific illustrations lavishly. Their references are almost a course in science fiction reading in themselves.)

Writing on "Social Science Fiction," Isaac Asimov traces the effects of science on Western Civilization and the breaking-out of these effects in fiction. Where science fiction is concerned, he traces a series of evolutionary stages: no specialization at all in the "primitive" era up to 1926, division into adventure and gadget phases in the Gernsback era (1926–1938), growing maturity with John Campbell's growing influence in this magazine.

Asimov is the first commentator I have seen who has made the obvious and important point that in its formative, Gernsbackian stage science fiction had to be "juvenile" in appeal, because its first readers were the large class who were not afraid of the idea of change—teen-agers, who had never known a stable society in the Victorian sense. "To the youngster, born in the midst of change, more change was only natural . . . This meant that science fiction had to lose most of its adult qualities" and revert to strong, fast action—"space opera" —wild inventions, and the "thought variant."

Social science fiction, in Asimov's definition, is that branch of literature which is concerned with the impact of scientific advance upon human beings. It is the science fiction of the "Campbell era," the science fiction

of today and tomorrow. There may be another division into "chess-game"—proceeding from our own present socio-economic culture, according to the rules of human behavior—and "chess-puzzle"—taking off from an artificial situation, but according to "chess" rules. Such stories as Fritz Leiber's "Coming Attraction" or Wyman Guin's "Beyond Bedlam" are prime examples of puzzle-stories; Asimov's own galactic empire tales of chess-game structure.

Can science fiction react on society? Yes, says Asimov—with the others I have already cited: in an era when the future is a complete puzzle, it can give us practice in thinking about the future instead of merely waiting for it to happen to us. To quote: "It says 'Change!' but it doesn't say how. It says 'Go!' but it doesn't say where." And probably, if it tried to say how or where, it would lose its force.

Arthur C. Clarke, in a chapter reprinted from the *Journal of the British Interplanetary Society*, implements all this by citing examples of the way in which science fiction ferreted and worked out the principles and details of rocket flight and space travel, and had a segment of the world ready for space flight. He offers hope to the devotees of interplanetary stories: there will always be more worlds beyond.

Most of the controversy over this book will probably center on Philip Wylie's chapter. I recommend it as a source of governed turmoil in one or more fan-club meetings.

Wylie—"Generation of Vipers"—argues that if democracy is to prevail over dictatorship, people need to know all there is to know about the basic truths of science and humanity. Science fiction could help to give them these facts and ideas. Instead, for every morsel of sound information and reasoning there is a deluge of fancy—nonsense—perversion of the truth instead of provision of the truth.

We in the United States, Wylie says, have not only not made it possible for the people to learn these necessary truths about their world and what makes it run, but we have *forbidden* most of them to probe for the truth of such matters as nuclear physics, military expenditures, foreign policy. Even the people's representatives — Congress — are not allowed access to the facts they need if they are to govern intelligently.

Science fiction readers understood the A-bomb and the H-bomb and the rest, but science fiction had and has done nothing to prepare them for the responsibilities at stake and the ideals involved in a world which must live with these things, Wylie maintains.

"Science fiction potentially can abet human wisdom but . . . the bulk of its present production has the opposite effect," he states. We have created a psychologically invalid false mythology of stereotypes and clichés with about as much relation to reality as Conan's world has to the real past—or to real myth. "The bulk, unlike the old legends, contains no germ of human truth whatsoever."

These are bitter truths to face, if they are truths, and I do not intend to do more now than face you with them and leave you to think about them. Perhaps we can then come back to them and examine them with more leisure. But first I must let Mr. Wylie speak for himself a little further:

"If science fiction plays any large part in leading the minds of men toward new goals, the goals toward which it has led most of its addicts to date are more evil than those of their less well-informed forebears . . . wild adventure, wanton genocide . . . gigantic destruction and a piddling

phantasmagoria of impossible nonsense . . . The fiction is of a perverse order in that it departs from what is scientifically known of man's nature. The science is most commonly employed either ignorantly or for sadistic melodrama. . . .

"(Writers) are nearly all ignorant of one area of science as large as all the rest: psychology . . . Yet, without (this) science . . . what they write is irresponsible, in the sense that it pretends to be 'modern' whereas it is contemporary *in detail only* — and inevitably, *in meaning*, archaic. . . . They but create a new and sinister folklore, in which the latest facts from the Massachusetts Institute of Technology are superimposed on a human insight hardly more developed than that of Bushmen."

There's more—much more: some less, some more arguable than this. As I see it, Philip Wylie is saying nothing about science fiction that he wouldn't and doesn't say about other fiction—his own fishing stories included. A difference is that science fiction claims to do much more than entertain: it pretends to a mission, and if the sentences above make you wince, it is because they hit home.

This isn't pure negativism. There is positive advice as well: "The proper function of the science fiction author . . . would be to learn the science of the mind's workings and therewith to plan his work . . . so it will represent in *meaning* the known significance of man. Logical extrapolations from existing laws and scientific hypotheses should be woven into tales congruent not with our unconscious hostilities and fears but with the hope of a subjective integration to match the integrated knowledge we have of the outer world."

A few words on the last two chapters of the book. Gerald Heard sees the machine as the hyphen linking modern man with his environment. He calls for much the same sort of responsibility and purpose in writing that Philip Wylie does: "Creative myth-making." A mystic and mystical writer, he believes that science fiction and fantasy should probe for possible meanings of the physical universe and man's relationship to it. As a writer, he practices what he preaches.

Summing up, Bretnor calls science fiction not a genre but an entire new literature—in prospect. This prospect will be realized only if writers successfully surmount such charges as those laid by Philip Wylie and others. And he finds quite as much confusion in the critics as in the stories they tear apart.

Bretnor states three differences between science fiction and non-science fiction: (1) science fiction is not self-restricted, nor restrictive of its readers —it turns to the new rather than the old; (2) it is not a literature of conventionalized false dichotomies, where everything is black or white, known or unknowable; (3) it is integrative—a literature not only of man, but of everything man does and thinks and perceives in the universe around him. It can be one of Murray Leinster's impersonal little tales of personalized robots or "In Hiding" or "Only a Mother" or "There Will Come Soft Rains." It admits emotion to science and the scientific method.

One answer to Philip Wylie's legitimate charges would be: "So who's perfect?" There is plenty of deathly serious sociological and philosophical writing in the world today which can be tagged with every one of his deficiencies and irresponsibilities. But if we aspire to having science fiction considered more than a form of entertainment, and believe it can exert a real social force, then we have to measure ourselves and it against the

maximum and not the minimum or the mean. I, personally, think the maximum has been raised. The minimum may have been lowered, leaving the vast middle ground of mediocrity exactly where it was. "Modern Science Fiction" should stir you to make your own decision about that.

THE BEST SCIENCE FICTION STORIES: 1952, edited by Everett F. Bleiler and T. E. Dikty. Frederick Fell, Inc., New York. 1952. 288 pp. $2.95

If for any reason—let's say psychiatrist's orders—I were to be limited to one science fiction book a year, I think that book would be the annual Bleiler-Dikty "Best Science Fiction Stories."

The 1952 collection—stories printed in 1951—outdoes the three that have gone before, and the vast strides science fiction is taking are shown by the fact that for the first time none of the eighteen selections comes from ASF. Undoubtedly when the next edition of the "Year's Best Science Fiction Novels" appears, the omission will be remedied, for this magazine shines in its longer stories.

To describe the eighteen stories in this top-notch anthology would take a full month's ration of "The Reference Library," and in any case you'll want to read them all yourselves, if you haven't seen the original versions. Particularly enheartening is the appearance of good new writers: John Christopher, Betsy Curtis, David Grinnell, Richard Matheson, Peter Phillips, Arthur Porges, Idris Seabright.

In Walter Kubilius' "The Other Side" we have a striking little story of a child's feeling of strangeness in his oddly limited world, and what happened when he looked behind the appearances. Alfred Bester's writing leaves an edge on the ordinary little time-travel yarn, "Of Time and Third Avenue," and C. M. Kornbluth gives an inevitable twist to the old Sleeper theme in "The Marching Morons."

Perhaps the warmest story in the book is Betsy Curtis' little tale of a Martian on Earth, "A Peculiar People." David Grinnell gives a neat twist to his lightweight story of a turn-of-the-(20th) century space-flight pioneer, and Wilson Tucker is a delight in his comedy "The Tourist Trade," in which tourists from the future parade through a present-day bedroom.

There is a grim inevitability about "The Two Shadows" in which William F. Temple combines the last-Earthman theme with the first-man-on-Mars gambit—and some wry comment on our own times and trends. From the English "New Worlds" comes John Christopher's "Balance," whose end also follows inevitably from his picture of a future society in which a super-mutant can destroy the balance of power. As for "Brightness Falls From the Air," by Idris Seabright, it is merely a vividly tragic little episode from the very far future—man's inhumanity to non-man.

Perhaps the least of the stories, though striking in its way, is Richard Matheson's "Witch War," told principally by implication. Peter Phillips' "At No Extra Cost" plays another variation on the theme of thinking robots, and Anthony Boucher's "Nine-Finger Jack" is another slight and wry vignette with a whiff of Dunsany's "Two Bottles of Relish" about it.

Fritz Leiber contributes "Appointment in Tomorrow," smooth and tricky but not quite up to some of his other visions of an unpleasant future, and Arthur Porges handles an old line well in "The Rats." Jack Vance, who has hitherto been a master of thud-and-blunder, gives us a neatly worked

out version of the isolated-society theme in "Men of the Ten Books." William Tenn has a grim little item of the near future in "Generation of Noah," and Mack Reynolds and Fredric Brown give us an even grimmer little commentary on our civilization in their time-traveler story, "Dark Interlude." Finally, there is a typical Ray Bradbury vignette of the future in "The Pedestrian."

There isn't a poor story in the lot, though some are of course better than others, and not all will suit all tastes. If hard-cover science fiction publishing should ever fall apart at the seams, and this department be dropped for lack of books to report, let us hope that Messers Bleiler, Dikty, and Fell will keep up their annual "Bests" as a series that you can order sight unseen.

BEYOND HUMAN KEN, edited by Judith Merril. Random House, New York. 1952. 334 pp. $2.95

The ideal anthology is essentially a super-issue of your favorite magazine. The editor is in a position equivalent to having all the best work of all the best writers at his—or her—disposal, and being able to afford them all. The joker is that someone else is likely to have been there first, and that readers by and large don't like reprints—even in a collection of reprints.

Judith Merril, with her top-notch paper-back anthology of two years ago, "Shot in the Dark," has already proved herself as knowing an editor as she is a writer—both as half of "Cyril Judd" and in her own right. Now, for the publishers who gave us the original super-collection of science-fiction shorts, "Adventures in Time and Space," and Murray Leinster's choice of "Great Stories of Science Fiction," we have a new and choice selection of twenty-one gems—a few of them fantasy—which have somehow stayed out of other people's anthologies until Miss Merril gave them new grace.

The fantasies, to get them out of the way, are Anthony Boucher's choice "Compleat Werewolf," epitome of the spirit of the lamented *UNKNOWN WORLDS*, Idris Seabright's Dunsany pastiche, "The Man Who Sold Rope to the Gnoles," Lewis Padgett's "A Gnome There Was"—with Lester del Rey's warm "Helen O'Loy" about the only over-familiar story in the book—and Robert Heinlein's gem of the helpful whirlwind, "Our Fair City."

These, you see, are stories about life-forms which seem strange to the beholder—even if (as in Laurence Manning's brand new "Good-Bye Ilha!") the strangers are human. Here, for the first time in any science-fiction anthology, is one of Murray Leinster's superb robotic shorts, "The Wabbler." Here are more familiar robotic themes: Malcolm Jameson's "Pride," about Old Tom who found a way to achieve a human kind of immortality, James Blish's "Solar Plexus"—the thinking ship, and perhaps Arthur Porges' disturbing miniature, "The Fly."

What are the rest? Let's run through them. If you remember them, you'll know for yourself the quality of this company; if not, take my word that it's one of the most distinguished companies of the year. Six, by the way, appeared here between 1938 and 1949; two came from *UNKNOWN*.

For other-worldlings in their own native heath, we open with Katherine MacLean's Venusian "teddy-bears" in "The Fittest," and later meet the unspecified symbiotes of H. B. Fyfe's "Afterthought." For invaders-of-Earth we have a broader selection, utterly varied: William Tenn's "The

House Dutiful", with its house-being, Eric Frank Russell's "The Glass Eye" (another seen from the invader's point of view), Mark Clifton's "What Have I Done?", or the trickers tricked.

For super-beings right here on Earth, there are Kris Neville's "Underground Movement"—the superman theme with an odd twist—John Christopher's "Socrates"—reminiscent of Stapledon's "Sirius"—and perhaps Theodore Sturgeon's "The Perfect Host." This leaves unclassified Fritz Leiber's grim picture of ultimate war, perpetually extended, "The Foxholes of Mars"—to me the one off-key story in the book—and Stephen Vincent Benet's joyous "The Angel Was a Yankee," which probably belongs back with the fantasies—except that the winged Yankee who is met by P. T. Barnum is so believable. But then, so is Boucher's werewolf—and Padgett's gnome—and Kitten, the co-operative whirlwind.

"Beyond Human Ken," had it been out longer, would probably have been up with the leaders in our recent poll. It belongs there.

THE LONG LOUD SILENCE, by Wilson Tucker. Rinehart & Co., New York. 1952. 217 pp. $2.50

A short time ago I stuck out the Miller neck to the extent of acclaiming Robert Heinlein's teen-ager, "The Rolling Stones," the best science-fiction novel of 1952. This was probably overexuberance in a year which had produced Kurt Vonnegut's "Player Piano" and C. M. Kornbluth's "Takeoff"—though Heinlein's book has a freshness and characterization which both these novels lack. Nor had I read Wilson Tucker's "The Long Loud Silence."

Having come to the book late, I already know that some critics whose judgment I respect and often follow do not like it one little bit. But then, you already know that I have broad and peculiar tastes in science fiction. Tucker belongs with the first team.

This is the story of what happened to Corporal Russell Gary, who woke up after the prolonged bender with which he had celebrated his thirtieth birthday and found eastern America dead or dying. Striking suddenly with guided missiles, an unnamed enemy had spread the spores of epidemic disease over the most densely populated part of the United States. Part of the government had dug in under the Pentagon. The Army and the rest of the authorities were west of the Mississippi where they had established a tight cordon to keep plague-carriers from creating new centers of infection.

The jacket calls Gary a professional heel. He is certainly not the noble hero of the traditional "after-the-atomic-war" yarn. He fights for his own life and comfort as viciously as do the other freak survivors he meets—nineteen-year-old Irma, the ex-teacher Oliver, the hill-girl Sally. He has one driving aim: to get out of the ruin of the bombed territory and lose himself in the surviving two-thirds of his

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country. He follows that aim doggedly and ruthlessly but humanly, a predator in a land of predators. But when he at last realizes the hopelessness of his situation, he does the only thing a decent human being could do . . .

Inevitably this book calls to mind L. Ron Hubbard's classic "Final Blackout." If its realism runs more to formula than that grim book, its people are more real and heel or not, Gary is always a more sympathetic protagonist than the Lieutenant. If Tucker keeps this up, he will have the competition on the ropes.

OUTPOST MARS, by Cyril Judd. Abelard Press, New York. 1952. 268 pp. $2.50

Why Cyril Kornbluth—who gave us "Takeoff" last spring—or Judith Merril—who has had two intelligent anthologies to her credit during the year—need to combine forces as "Cyril Judd" is anyone's guess. This much must be admitted, though: neither loses a bit in the combination.

"Outpost Mars" was serialized in *Galaxy* as "Mars Child" in 1951. It's a sound and relatively simple story of the struggles of a young colony to establish itself on a self-sustaining basis, free itself of its ties to Earth, and become truly Martian. Above all, it is the story of the efforts of these young people to bring forth a "Mars child" who will live—live without an oxygen mask, without any artificiality, as the first of a new race of planet-conquering men.

Dr. Tony Hellman, head of the little Sun Lake colony, has other problems to worry him. The Sun Lake laboratory keeps the colony going on a precarious basis while its people try to create new crops which will make them independent of food from Earth. Across the Rimrock Hills is the ruthless Brenner who claims that someone in Sun Lake has stolen a hundred kilos of deadly *marcaine*—priceless to Earth medicine, and to drug addicts. If the shipments of radioactive isotopes which the Colony is shipping to Earth are opened, searched, and repacked, they will miss the next rocket—and Sun Lake will collapse.

In the midst of the trouble, Sun Lake is blessed with a visit from the planet-trotting journalist, Douglas Graham, whose story may save or ruin Sun Lake's efforts to create a self-sustaining colony on Mars. An hysterical mother begins to see Martian dwarfs, straight out of a TV show, avid to kidnap Earth children as little people have been in legend since the dawn of history. And at the climax, little Sunny *is* stolen . . .

There's nothing pretentious or cosmic about the plot—good, old-fashioned greed and villainy up against a crowd of likable but humanly fallible people who share a seemingly hollow dream. I'm a little unhappy about the marcaine angle, which seems unnecessary—but I suppose Brenner would have been too unmitigated a stinker if his drugs hadn't been stolen and he had been harassing Sun Lake out of sheer cussedness and avarice.

I think you'll like "Outpost Mars." It's the kind of book which wins converts to science-fiction among general readers.

An ASF Factual Article

IN CASE OF FIRE...

By WALLACE WEST

Once upon a time, *water was what you used to put out a fire. But present technology has produced some wonderful new products—and some fantastic new fire-hazards, and hazards for the fireman. You don't blithely squirt streams of water about a modern plant using metallic sodium, magnesium, high-voltage electric power, and assorted other forces that become appallingly violent when water gets around!*

So he drove out the man; and he placed at the east of the Garden of Eden Cherubims and a flaming sword which turned every way . . . *Genesis* 3:24

THE fiery barrier that kept Adam out of Paradise after his first careless nibble at the fruit of knowledge still blazes across the path to man's progress. His incomplete mastery of a host of new metals, chemicals, industrial processes and radioactive weapons, plus his downright carelessness, are hiking fire losses until they threaten to hamstring technological advances.

Three-quarters of a billion dollars' worth of homes, factories and materials went up in smoke throughout the United States last year. That is a stiff levy on a country already saddled with huge foreign aid payments and Cold War costs, even if one discounts the eleven thousand or so lives lost and the additional thousands of persons who were maimed by fires.

There are, however, two even more disturbing factors involved: the uninterrupted rise in the fire loss *rate* and the fact that it seems next to impossible to get people to do much about the situation.

Not so long ago fire losses were creeping upward about 3% each year. That was explained away by the country's rapid growth. Then the annual increase rate began hitting 4%, 5% and, during the first nine months of 1952, the all-time high of 6.1%. To make things worse, losses for last September were 10.4% higher than those during the same month of 1951. Yet September averages fewer fires than any other month. Losses soar 75% during the Christmas season, recede slightly and equal the holiday holocaust around March 1st.

Despite constantly growing hazards introduced by the mechanization and "chemicalization" of modern society, fire could be kept under reasonable control if no human element were involved. In other words, a factory run by efficient robots would have very few blazes. The experts are unanimous in agreeing that an overwhelming majority of all fires are due to carelessness, stupidity or plain orneriness.

Back in 1923, a Royal Commission traced forty per cent of five thousand two hundred eighty-one British fires *directly* to carelessness and wailed that few citizens concerned themselves much with that shocking situation. It added that, in all parts of the world, the downward curve of business during a depression is offset by the rising

graph of fire losses. Arson? Perish the thought, said the commissioners. But when trade gets bad, outlays for fire protection are among the first to be trimmed while debtors who have their stores or factories covered by insurance just seem to become "poor risks." (Those wishing to pursue this line of investigations are referred to H. G. Wells' delightful novel, "The History of Mr. Polly.")

Today, in the United States, *nine-tenths* of all fires are attributed to carelessness by the National Board of Fire Underwriters. To those who disagree and lay the trouble to severe American winters and extensive use of wood as a construction material, the Board replies by pointing to Wisconsin, Minnesota and the Dakotas. Fire losses in those frigid states run from a fourth to a third lower than the national average. On the other hand, losses in the warm southern and southwestern states average about that high *above* the norm.

Establishment of rigid safety standards, development of better fire-fighting equipment and fire-quenching chemicals, jacked-up insurance rates and widespread advertising and publicity undoubtedly have kept the fire loss rate from going right through the roof. But so far they have failed to induce Americans as a whole to adopt the "good housekeeping" methods of the frugal folk in the northwest. As a result, the newest chemicals are not powerful enough, nor is water wet enough to keep the red vampire in check.

The fact that water may be the worst possible thing to throw on a fire has been known for centuries, of course, but, until very recently nobody understood exactly why this should be so. Firemen did have some "rules of thumb," the best-known one being that, if a blaze got well started in a whisky warehouse, trying to put it out was a dangerous waste of time and water. But, in general, the hoses were used first and the often-lamentable results were explained later.

The first spectacular proof that water actually feeds some fires was provided in 544. A.D., during the Persian siege of Edessa, an important Roman town in Asia Minor. King of Kings Khusrau could not breach the walls so he built a timbered ramp overtopping the battlements and planned to march his army along it and right into the city. To protect the timbers he had them covered with earth and stone.

An unknown engineer induced the despairing city fathers to sink a shaft under the towering ramp. He filled this with cedar wood, sacks of bitumin and lumps of sulphur, drenched the whole with oil of turpentine and set it afire.

Khusrau was annoyed, as many another builder has been since then, to find his "fireproof" structure in flames. He set his entire army to dumping thousands of barrels of water on the blaze.

"Then was the King of Kings confounded in his mind," wrote an Edesan chronicler, "for the water did not quench the flame of the chemicals. Nay, a choking steam arose, driving away living men. The great work fell into charred ruin while poisonous fumes hung above it . . . After that the host of the enemy went away."

Firemen called to fight a blaze in the Holland tunnel on January 2, 1946, also were "confounded in their minds" when water served only to increase the volume of foul-smelling smoke. Donning respirators and pushing their way into the tube, the firemen soon found themselves sticking to the roadway like flies to flypaper. A truck loaded with twelve tons of chewing gum and several cases of shoe polish was burning. . . . Traffic stopped for four hours while the goo was being extinguished with chemicals and scraped off the pavement!

The old "rules of thumb" no longer are enough, now that industries are working strange new materials at high temperatures under pressure, vacuum or artificial atmospheres; now that the armed forces are becoming acquainted, if not exactly familiar, with atomic explosives, and now that farmers are turning more and more to mechanization, chemurgy and large-scale crop drying.

Today's fireman must be something of an electrician, chemist, physicist and mathematician. He must know why it is pure insanity to use water, foam, soda-acid, carbon dioxide or carbon tetrachloride on a sodium or potassium fire. And how many pounds of what detergent should be added to a two and a half-inch hose stream to make water "wet" enough to penetrate twenty feet of hay in a burning barn.

Manufacturers and their employees must understand such things as: To avoid disastrous explosions never store a liquefied petroleum gas like butadiene—the main component of synthetic rubber—in any tank until the air inside has been displaced by water and the water by nitrogen or a similar inactive gas.*

Overenthusiastic physicians, as well as soldiers and Civil Defense personnel, have to be made to realize the dangers of radioactive substances. One general practitioner asked the maker of a powerful isotope to "send samples by return mail."

When it is considered that the burning of Moscow to stop Napoleon cost the Russians $150,000,000; that Mrs. O'Leary's cow kicked over about $200,000,000 at Chicago, that the 1906 San Francisco fire loss hit a quarter billion dollars and that the burning of a modern city would double or treble that figure, it is obvious that correct answers to the above questions and a host of others must be found, and soon.

Citizens of ancient Rome provided part of the answer in 64 A.D., when they organized the first fire-fighting brigades even as Nero fiddled. The Great Fire of London in 1666 caused formation of the first fire insurance companies. Those companies revived the almost-forgotten brigades. But, until a few generations ago, firemen put out blazes only in buildings insured by the companies that sponsored, equipped and sometimes paid them. Other structures could go hang!

And they went hang until the disastrous Chicago and Boston fires of the early 1870s shocked the nation into realizing that a modern, co-operative, scientific approach had to be made to the problem of protection. Such work in residential and industrial areas was pioneered by the National Board of Fire Underwriters, an educational, factual and engineering organization supported by more than two hundred capital stock insurance companies. In 1910 another organization became active in the field as the result of great forest fires that swept northern Idaho and other parts of the West. This was the United States Forest Service with its impressive network of watchtowers, guards and rangers. Since then both organizations have

* The Earth's air is "loaded with oxygen, one of the most active gases known. A being adapted to Venus, with its embalming fluid atmosphere of inert formaldehyde, probably could not survive for three minutes on Terra. And his spaceship might well be made of materials that would ignite or explode spontaneously before landfall.

There are more deadly worlds than Earth, of course. Jupiter is one. A human entering its atmosphere of methane, frozen ammonia crystals and ammonia vapor would be well advised to wear a gas-tight suit of non-reactive plastic. (Natural rubber or aluminum would be eaten away in no time.) Also, unless he wanted to go out in a blaze of glory, absolutely no water vapor could be allowed to escape from the exhaust vent of his respirator.

received invaluable aid from industry, various government agencies and public and private educational and research organizations.

Since the work of the Forest Service has the more spectacular angles, let's take a look at it first. To patrol the half billion acres of heavily wooded land under organized protection the Service has developed its own fire-weather observatories and FM communications network. It recruited and trained the famed Smoke Jumpers. They parachute to the scene of a fire as soon as it is spotted and usually succeed in smothering the blaze before it has a chance to spread.

The Service supplies its fighters by planes or helicopters when necessary. It has conducted widespread experiments in co-operation with the Air Force to learn how to extinguish fires by means of special bombs. It is working closely with Drs. Langmuir and Schaefer of General Electric to find out how to seed clouds with dry ice and other materials. It is hoped that such seeding not only will cause rain where and when it is most needed but eventually will control the lightning storms that so often are responsible for forest fires.

Despite these exciting projects, the Service is proudest of the fact that it has reduced forest fire-fighting to such a highly mechanized science that it has been able to extend its service between twenty-five and thirty-five per cent since 1945.

Next on the List-of-Things-To-Boast-Of is the Service's very own Smokey Bear. Smokey, the one fire prevention symbol that has caught the public imagination, frowns ingratiatingly from posters and advertisements, talks over radio and TV and has developed a pleasant screen personality. He exhorts campers to pour water on cooking embers, break their matches and do all the little common sense things most people forget. Smokey is given a lion's share of the credit for saving vast tracts of forest and endless head of game from careless nature lovers. Without his help, rangers say, losses might be double the present figure of fifty million dollars yearly.

The work of the National Board and other civilian organizations may not be as exciting as that of the Forest Service but is just as essential to the health and growth of America's industrial civilization. Such co-operating groups include Underwriters' Laboratories, Inc., Civil Defense, the International Association of Fire Chiefs and the National Fire Protection Association. Working in close harmony with the armed services and municipal, county, state and federal governments, they draw up model fire prevention ordinances, electrical and building codes and standards for everything from hose threads to hydrants. They also handle such chores as running twelve-hour endurance tests on fifteen hundred types of water pumpers.

The standards and codes formulated to reduce fire hazards are crowning achievements of the NBFU and NFPA. There are one hundred eighty of these, all written by experts on such varied subjects as automatic sprinklers, airplane hangars, magnesium, flammable liquids and liquefied gases. About a million copies are distributed without cost by the NBFU each year.

In addition, the Association devotes much attention to public education and is the international sponsor of Fire Prevention Week each October, as well as publishing the *NFPA Quarterly*, the foremost technical journal in its field. The Board prints highly technical research reports on such subjects as "Precautionary Fire

and Explosion Safeguards in the Use of Chlorine Dioxide for Industrial Bleaching" and "Hazard Survey of a High-Voltage Electrostatic Process for Spray-Deposition and Dip-Detearing of Paints."

At first glance, such reports, standards and codes look dull and uninteresting. Closer inspection shows that they contain much exciting information of equal interest to the theoretical scientist, the practical technologist, the business man, the general public and the worker-on-the-job.

Take, as an example, the chlorine dioxide now used widely in bleaching, aging, clarification and maturing flour, animal fats, soap oils and syrups. It is so unstable that it cannot be shipped but must be made on the spot from chlorine and sodium chlorite. Nothing need be said about the poisonous characteristics of pure chlorine but it is not so well known that the chlorite can ignite on contact with floor dust, gloves, mops or brooms. And, in concentrations over ten per cent the dioxide is spontaneously explosive!

To the layman it might appear that he would be much safer sitting in the middle of the Great Red Spot on Jupiter than in the presence of such a combination of ferocious chemicals. Yet it is a fact that, although three hundred fifty chlorine dioxide generators were installed in flour mills and fat rendering plants during 1951 alone, they have behaved with amazing sobriety. (One generator which had been fed an excessive amount of chlorine did explode with enough force to drive sections of an eight-inch brick wall two hundred feet from the point of origin.)

The good behavior of the new bleach almost certainly is due to widespread adoption by manufacturers of a code of precautionary measures proposed by the NBFU. This code takes up several pages of fine print. The section dealing with sodium chlorite can be boiled down to the following:

STORAGE REQUIREMENTS:

(1) Keep storeroom area cool and dry. Store *nothing* but sodium chlorite in it.
(2) Store chemical only in original shipping containers, keep covers always in place to exclude contamination by dust, oil, wood, sulphur, et cetera.
(3) Use only clean metal equipment and tools in handling the salt.
(4) No smoking! Avoid all contact of stored salt with heat or fire.
(5) Avoid spillage of salt or solution—keep area clean.

EMERGENCY PROCEDURES IN CASE OF ACCIDENTAL SPILLAGE:

(1) Sodium chlorite flakes should be swept into a metal container and flushed down a drain that discharges into a sewer.
(2) Sprinkle the area with powdered anhydrous sodium sulfite. (10 lbs. for each gallon of solution spilled, not less than ½lb. per 10 sq. ft.)
(3) Mop the area with a *minimum* of water. Wait 15 minutes and repeat.
(4) Flush the residue down a drain with a considerable amount of water. Clean mop or brush thoroughly on completion of each cleaning operation.

EMERGENCY PROCEDURES IN CASE OF FIRE:

(1) Should a fire occur in the sodium chlorite storage area, apply water and ventilate the area. (Overheated containers may explode.)
(2) Should a fire occur in the *vicinity* of the storage area, maintain a spray of water over the outside of the containers to keep them cool.
(3) Clean-up operations after a fire are important. If sodium chlorite contamination is suspected, apply neutralization procedure as outlined for accidental spillage.

This sample code has been given in bare outline to provide a hint as to what the modern industrialist is up against if he is to meet competition by making use of the latest available techniques. Other codes are even more complicated. It would be impossible in an article of this length to do more than hit their highest spots.

There is the matter of magnesium, the metal taken from sea water which may eventually replace steel and even aluminum. The ideal spot for a magnesium refinery would be on the Moon because it works best in a high vacuum. (That also applies to titanium, zirconium and other refractory metals now coming into use.) Sawings and coarse grinding of magnesium castings may produce sparks capable of igniting the fine dust. This in turn may touch off the castings. Spillage of molten magnesium metal on a damp floor or mold is quite likely to cause a fire. And a water stream played on the blaze is pretty certain to result in an explosion. The biggest bang of all can be expected when a large piece of magnesium is mistaken for aluminium and tossed into a smelter.

Have these and other hazards proved insurmountable? Far from it. Good housekeeping and ingenuity have solved many of the major difficulties. Extinguishing powders and gases such as boron trichloride have been substituted for water. Dust is sucked away from lathes by ingenious vacuum cleaners and turned into sludge until it can be taken to a safe place for burning. A silver nitrate spray turns black on magnesium and enables it to be weeded out of aluminum scrap. Only non-sparking tools are used in working the metal and supplies are stored in small quantities in fire-resistant buildings.

Uranium—that is U238, the "tame" kind—is even more of a problem child. It is pyrophoric, which means that in finely divided form it may ignite spontaneousiy on contact with air. This may occur even if the powder is dry. The resulting fire burns at 2300°F.

Uranium may be stored under water but this releases free hydrogen, another bad actor. Oil is better, but if any of the metal sticks above the "water line" it will ignite. About the only safe way to ship large quantities of uranium dust is in specially constructed explosion-safe dry boxes filled with a nonreactive gas such as argon. Despite its value, some manufacturers won't even consider trying to reconvert the dust. They burn it with extreme caution in small quantities, either under water or spread out on a thick steel plate. (It can burn in an atmosphere of pure carbon dioxide so extinguishers containing that gas are of no value. Neither are those using carbon tetrachloride, soda acid or foam.)

More intrepid dealers oxidize the scrap to comparatively harmless uranyl nitrate by means of nitric acid. Others degrease the powder and briquette it under high pressure. Then they ship the stuff by courier and equip him with a plentiful supply of G-1 powder—a commercial preparation with a graphite base—graphite chips, powdered talc or dry sand under which to bury the argon-filled container in case it becomes restive.

The fire doctors disagree when they talk about the best ways to deal with atomic explosions or blazes involving radioactive materials. The Joint Fire & Marine Insurance Committee on Radiation has put out a tentative report. The International Association of Fire Chiefs has published two of them. But, since nobody has been told the size or power of A or H-bombs that may be expected to fall if another war comes and since the Atomic Energy Commission exercises the strictest kind of control over shipments of more than one hundred different kinds of radioactive isotopes, the whole discussion seems academic. Dr. L. G. Cook, of the Chemistry Branch, Atomic Energy Project, National Research Council, neatly summed up the situation in a recent speech to members of the Canadian

Manufacturers' Association. Said Dr. Cook:

"Pretend I was suddenly made Assistant Fire Chief in say, Toronto: As far as fires following an atomic bomb are concerned, that is a province of civilian defense and I would like to hear someone tell me what to do as much as you would.

"As to fires following a reactor explosion . . . As leader of a municipal brigade, I should lead my men energetically in the other direction. In case of fire in a large-scale processing plant, I should diligently lead my brigade in the opposite direction and allow the plant employees who know where the hazards are the full responsibility of fighting the fire or letting it burn down as they pleased. That business is too risky for anyone not intimately familiar with the plant to deal in. . . . If it *were* necessary to be around the outskirts of the fire to protect houses in the vicintity, I should insist on wearing a good dust mask.

"Now we come to the only group of hazards with which a municipal fire department should ever have to deal. This consists of mgs. to gms of radium or other equivalent radioactive materials present in a radium dial painting plant, in a hospital, in an industrial plant, in a University, or in an express car, truck, airplane or other conveyance. . . . I should lay my plans in case of fire based on the assumption that under no circumstances did I intend to inhale any of the stuff as dust, or eat it, even at the risk of letting the place burn down. . . .

"Another thing I would like to be able to have or borrow after such a fire would be a Geiger counter. The purpose of this is to find the stuff again—not so much for the owner's sake because it is probably insured—but to make sure none of my firemen had accidentally got some of the stuff in his trouser cuff."

The good doctor could have added that the smartest thing for his firemen to do would be to burn their clothes, shave their heads and pare their nails to the quick!

The experts speak with more authority when they deal with such unrestricted subjects as potential hazards in the molten salt baths used for heat treatment of metals. These baths are prepared from at least twenty-seven different chemical salts, particularly sodium and potassium nitrates, sometimes in intricate mixtures. The have largely replaced case hardening and even the newer heat treating of metals in high-pressure artificial atmospheres of inert gases. This came about because manufacturers found that necessary temperatures ranging from 300°F. to 2400°F. could be imparted to metals with far greater speed, accuracy and economy in a molten liquid. Parts of castings also could be "spotted" when necessary.

Baths are used to harden or anneal the surfaces and change the interior characteristics of aluminum, magnesium and other nonferrous metals and alloys. They also blue, temper, martemper, austemper, quench, normalize, anneal, preheat, braze, carburize and cyanidize a whole host of new steels. (If you want to know what some of those terms mean, *you* can look them up in the dictionary!)

At such temperatures the baths are extremely touchy. A drip from an overhead steam pipe set one off not long ago with the explosive force of a thermite bomb. An Italian factory was reduced to forty carloads of rubble when someone tried to heat up a frozen bath in a hurry. A municipal fire department accidentally caused a one-hundred-seventy-five-thousand dollar damage to the heat-treating division of a large midwestern metal-working plant when its members played a hose on a bath and caused a steam explosion that knocked most of the shop into matchwood. And, of course, there was the inevitable that happened when a workman mistook a magnesium casting for aluminum. Notice that every one of those major blowups were due either to poor housekeeping or to carelessness. All sorts of educational campaigns, warning posters, cleanup drives and the strictest possible building and operating

standards are being used to reduce the risks.

Similar preventive measures have paid off handsomely in the oil business. When petroleum fires occur they are almost certain to be spectacular. The speed with which they are put out is even more breathtaking. This is due to good housekeeping and the finest fire-fighting personnel and equipment.

Not so long ago, when an oil well caught fire it was written off as a total loss. Now it can be brought under control in short order. Often this is done by drilling a relief well nearby. This hole is curved until it connects with that of the burning well many feet underground. Then mud is pumped from the relief well until the oil or gas flow from the other is temporarily choked off. Finally, a set of valves called a Christmas Tree is installed to control the offending well.

Storage tanks, refineries, pipe lines, tankers, tank cars and trucks and service stations now are built to rigid safety standards worked out by the American Petroleum Institute in co-operation with the NFPA and NBFU. The latest tankers, to cite just one instance, carry a mechanical foam installation consisting of:

Two 500-gallon-per-minute pumps.

A 100-gallon and a 200-gallon pressure proportioner for injecting foam.

Seven foam applicators attached to fire hose.

Six marine floor nozzles in the boiler room, eight in the engine room and three in the two pump rooms.

Spray deflectors to protect the pumps, overhead piping and floor areas.

Salt water mains serving some 30 fire stations with water or steam.

Paint and lamp lockers, generators and engine room protected by piped carbon dioxide.

Cargo ventilators equipped with flame arrestors.

A plentiful supply of hand fire extinguishers.

More than 1,000 gallons of foam liquid.

As a result of such precautions the industry has one of the best safety records in the nation although it deals with a highly flammable material. But it continues to conduct intensive research into the fire-fighting problem. Its newest wrinkle was demonstrated last November 18th, by the Socony-Vacuum Oil Co., Inc., at its Paulsboro, New Jersey, refinery. In the presence of five hundred onlookers, Joe L. Risinger, head of the company's safety and fire protection forces, set fire to a tank containing two million gallons of heating oil.

Risinger waited until the flames were roaring fifty feet high. Then he snuffed them out in thirty-seven seconds by the agitation method. This consists of injecting compressed air into the bottom of the tank. Cool oil is "rolled up" to the top. This reduces evaporation below the level where it can sustain a flame. An ordinary air compressor and some hose are the only tools used.*

The booming plastics and synthetic rubber businesses, both of which obtain most of their raw materials from petroleum, are vying with their mother industry for high safety showings. Luckily, none of the more than two hundred different brands of finished plastics now on the market ignite with the enthusiasm that old-fashioned pyroxylin used to display.

Some of the new plastics are slow-burning; others are self-extinguishing. A number can generate flammable gases or poisonous vapors such as carbon monoxide, oxides-of-nitrogen

* The use of agitation—really a form of vibration—to stop fires is attracting considerable attention these days. It is now possible, under laboratory conditions, to extinguish a candle flame with supersonic vibrations from a souped-up auto horn. And it is conceivable that, in the not-too-distant future, the same siren that brings firemen sliding down their poles will be used to put out the blaze it has warned of.

and hydrogen cyanide. A few compounds exhibiting low burning rates in their rigid form can become highly explosive when suspended in the atmosphere as finely-divided dust, or dangerously flammable when prepared in the form of fine fibers. (Remember the "sweater fires" of a year or so back.)

The study of causes for the generation of toxic vapors is still in its early stages but much progress has been made on licking the dust problem. This has been done by installation of dust-tight equipment, vacuum collecting systems, inert gas atmospheres in grinding and pulverizing equipment and transport systems, magnetic separators for the removal of bits of "tramp iron" that might cause sparks in the machinery and explosion pressure relief vents or self-releasing weak openings—rupture diaphragms —to prevent destruction of housing, machinery or personnel. Workers also have been taught to use water with great care in fighting a fire. Certain flammable plastic solvents *can* be diluted to the point of making them nonflammable. Water spreads others on its surface and adds greatly to the difficulty of fire control.

A good argument could be made for a cybernetic civilization by contrasting the low incidence of serious fires in the highly-mechanized oil, synthetic rubber and plastics industries with shocking conditions existing in the equally hazardous but far less mechanized cotton industry. Principally because of bad housekeeping on the part of management and carelessness by low paid workers, cotton warehouse and gin fire losses in the United States have run as high as seventeen million dollars in a single year. It is as if crops from two hundred thousand acres of the nation's best land were being dumped into the ocean every twelve months.

And what causes such widespread destruction? Atom bombs? Bacteriological warfare? Little green men in flying saucers? No, all the evidence points to strike-anywhere matches and cigarette butts as the chief culprits. That is because cotton filaments are small tubes full of air. A match or butt entrapped in a bale continues to burn merrily until, in box car or warehouse, the bale explodes, hurling burning cotton in all directions. Sensitive infrared detectors and bayonet thermocouple probes are being developed to detect fire-packed bales and quench them with injected liquid extinguishers, wet water or inert gases. But until No Smoking signs are strictly observed and yards and warehouses are properly built and protected, such gadgets will have limited usefulness.

Bits of tramp iron ranging from nails to can openers, bottle caps and hunks of rust are responsible, along with static electricity, for causing many cotton gin fires. Sparks ignite the cotton dust and that is all, brother! Magnetic separators of either the electric or permanent type help. So do dust collectors, electronic metal detectors and equipment made of non-sparking copper-beryllium alloys. Newer tricks include the elimination or control of static by bonding together and grounding the sheet-iron plates of gin structures and warehouses or actually grounding the air within such buildings with ionizing radiation from ultraviolet units and radioactive isotope tapes. A few modern plants reduce static by controlled humidification and moisture restoration with sprays containing chemical conditioners or wet water agents.

So a gin operator cleans up his plant, enforces the no-smoking rule and installs the latest safety gadgets. So he has no fires. So he loads the big bales into box cars and, with a sigh of relief, consigns them to a cloth manufacturer. So the railroad he uses converts

from steam to Diesel locomotives. AND, AT ONCE, THE NUMBER OF BALES THAT CATCH FIRE IN TRANSIT IS DOUBLED.

Why? Well, it seems that Dieselized freight trains travel much faster than steam trains. This, in turn, causes increased jostling and tossing about of the bales. The spring synchronization encountered on new-type box cars results in up-and-down harmonic vibrations. The metal bale bands rub against nails and bolts in the car and sparks fly! No wonder that cotton losses now amount to sixty per cent of all general cargo damaged by fire. And no wonder teams of experts labor over the years to develop better ways of loading and bracing, to perfect wire cable bale bands that will sink deep into the cotton instead of remaining on the surface as the present sheet-iron ones do and to invent electronic spies that will warn of locked car fires before they go out of control.

The truth of the matter is, though, that one big reason why cotton is losing out to synthetic fibers is the cruel fire loss that keeps whittling away at profits. And there seems no real way of cutting that loss except by intensive mechanization.

So far, this article has emphasized the *industrial* aspects of fire protection. This has been done because the majority of improvements in fire-fighting techniques have been made in that field. The Forest Service, it is true, has done its share. The Air Force is experimenting with halogenated agents some of which have jawbreaking names like 1, 2-Dibromo-2-chloro-1, 1,2-trifluoroethane ($CBrF_2CBrC1F$) while others cost as much as one thousand dollars a quart but show truly spectacular quenching abilities. The Force also has gone far toward perfecting an aluminum foil suit for fire fighters which absorbs only about half the BTUs picked up by the standard "bunkin" suit.

America's splendid network of paid and volunteer fire companies should be given credit. Civil Defense expects that the protection, policing and even the governing of rural areas will fall largely upon the shoulders of the Vamps in case of an atomic disaster. Research labs of State and other universities have made their contributions. So has the United States Weather Bureau: Its new electronic computer, nicknamed Maniac, has just been installed at the Los Alamos Scientific Laboratory.

Consider the matter of safety at sea for a moment. It is extremely doubtful that fire could get out of control on a modern ocean liner as it did on the old *Morro Castle*, for example. Centralized extinguishing equipment such as that installed on the tanker previously mentioned, fire-resistant bulkheads, and duplicate alarm and communications systems are standard now. So are small but vital refinements as leaving enough space under fire doors so hose water can escape instead of collecting on upper decks until it capsizes the ship.

Experience gained in fighting industrial oil fires is making plane travel safer. A nonexplosive fuel probably will have to await the introduction of jet liners but nonexplosive lubricants are in general use.

Large numbers of lives are being saved after crashes because, paradoxically, firemen have learned that it is fruitless to attempt to extinguish a freely-burning plane carrying hundreds of gallons of gasoline as fuel. Instead, they beat a temporary path through the flames, using CO_2 extinguishers, water spray, wet water, foam or dry chemicals. After passengers have been rescued from the cabin, firemen stand by to keep the blaze from spreading. Their record in

controlling such threats has been remarkably good even though they have done some of their fighting under fantastic odds.

Train travel, too, is made safer by techniques developed at industrial plants. Hot boxes, the terror of travelers in other days, have been made obsolete by roller bearings. Steel coaches trimmed with aluminum and plastics have replaced the wood and veneer death traps of the past. Locomotive fires due to collections of oil dirt in hard-to-get-at places have been practically eliminated by semiautomatic vapor degreasers that keep big Diesels almost antiseptically clean.

Skyscrapers are safer because of lessons learned the hard way by industry when "fireproofed" plants insisted on burning to the ground. A sixty- or seventy-story building is too expensive to take the slightest chance with, as are the lives of thousands of persons who might be trapped. So tall buildings are constructed in such a way that, even though office furniture, carpets, et cetera, should burn to a cinder, their structures will remain relatively undamaged. Steel beams, floors, main electrical circuits, fire-fighting equipment, stairways and elevators will continue to function under such circumstances. In addition, the law requires that skyscrapers must be tenanted by persons engaged in nonhazardous occupations—bankers, lawyers or ad agencies instead of salt bath operators.

Skyscrapers are not "fireproof." No man-made structure can be. But they are highly fire-resistant and liberally equipped with hand extinguishers, hose and plentiful supplies of water. Most of them have automatic sprinkler systems. The proof of their safety came when a B-25 bomber dived into the Empire State Building several years ago and drenched the interior with gasoline. There was a nasty fire, of course. It gutted most of the seventy-eighth and seventy-ninth floors. But, because only the furnishings burned and because the New York Fire Department had drilled itself for years to meet just such an impossible situation, it brought the flames under control within nineteen minutes!

Despite such heroic examples of modern fire protection techniques, future historians may be more impressed by the way in which those techniques were developed. In most

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instances they were *not* the result of government edicts, handed down from above. Instead, the rigid codes and standards of the NBFU and NFPA were drawn up and adopted by volunteer committees made up of fire chiefs and marshals, research technicians, manufacturers of extinguishers and other equipment, lawmakers, business men and representatives of the general public.

It is a high compliment to the common sense and good will of average Americans that nobody had to order them to join such committees and that nobody "railroaded" a single code or standard through to adoption. Time could have been saved by so doing, perhaps but those concerned discovered more than a generation ago that "a man convinced against his will" makes a poor fire risk.

So, over the years, committeemen have wrangled about such apparently minor matters as the best way to standardize hose couplings, or how can "my company" stay solvent if it has to spend so much to make a new plant fire resistant, or why shouldn't some experimental extinguishing fluid be approved, even though it is so chemically unstable as to be as dangerous as the fire it might put out?

Plenty of angry words have been spoken. Committeemen have stormed out of meetings and sworn they would never be caught dead in another. Once or twice they have come almost to blows. But, without exception, argument and compromise have brought about virtually unanimous agreement in the end. Only after such agreement was achieved could a code or standard be recommended for adoption by industry and for incorporation into law.

It is pretty hard for a steel company, let us say, to violate a code which its own management has had a hand in drawing up. No matter what the temptation to cut corners in building, equipping or operating that new plant, the fact remains that, if the code is violated and the company is caught short, it can have no defense in court. John A. Neale, chief engineer of the National Board of Fire Underwriters, sums up this remarkable situation as follows:

"It is certain that new processes and materials possess such inherent hazard that, to be used at all, they must be accompanied by appropriate developments in fire protection. The only way we have found that permits us to evaluate the hazards and prescribe the remedies is our committee setup. Maybe we are pioneering a new way for keeping our nation's economy running smoothly without being fully aware of what we are up to."

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WHIRLIGIG WORLD

By HAL CLEMENT

Concerning the planet *Mesklin—and how one author goes about setting up the environment for his story. There's an immense amount of detailed, careful consideration behind each of the strange features of Mesklin!*

WRITING a science fiction story is fun, not work. If it were work I wouldn't be writing this article, which would then constitute a chapter for a textbook. I don't plan to write such a text, since if the subject is teachable I'd be creating competition and if it isn't I'd be wasting time.

The fun, and the material for this article, lies in treating the whole thing as a game. I've been playing the game since I was a child, so the rules must be quite simple. They are; for the reader of a science-fiction story, they consist of finding as many as possible of the author's statements or implications which conflict with the facts as science currently understands them. For the author, the rule is to make as few such slips as he possibly can.

Certain exceptions are made by both sides, of course. For example, it is commonly considered fair to ignore certain of Dr. Einstein's theories, if the story background requires interstellar travel. Sometimes a passing reference is made to travel through a "hyperspace" in which light can travel faster or distances are shorter, but in essence we ignore the speed-of-light rule since we can—so far—see no way around it. The author assumes that problem, or perhaps others equally beyond our present ability to solve, to be answered, and goes ahead from there. In such a case, of course, fair play demands that all such matters be mentioned as early as possible in the story, so that the reader has a chance to let his imagination grow into the new background.

I always feel cheated when the problem which has been developed in a story is solved by the discovery in the last chapter of antigravity, time travel, or a method of reviving the dead; such things *must* be at least near full development and known to the reader long enough in advance to give him a chance to foresee the ending. I have always assumed, perhaps wrongly, that others felt as I do; I try to write accordingly.

In "Mission of Gravity" I've been playing this game as fairly as I could.

The author has one disadvantage, of course; all his moves must be completed first. Once the story is in print, the other side can take all the time in the world to search out the mistakes; they can check with reference libraries or write letters to universities, if they play the game that seriously. Sooner or later the mistakes will come out; there is no further chance to correct them. If "Mission of Gravity" contains such errors, they're out of my hands now. I did my best to avoid them, but you still have a good chance to win. As I said, my moves were fun, not work.

The basic idea for the story came nearly ten years ago. In 1943 Dr. K. Aa. Strand published the results of some incredibly—to anyone but an astronomer—painstaking work on the orbit of the binary star 61 Cygni, a

star otherwise moderately famous for being the first to have its parallax, and hence its distance, measured. In solving such a problem, the data normally consist of long series of measurements of the apparent direction and distance of one star from the other; if the stars are actually moving around each other, and the observations cover a sufficient fraction of a revolution, it is ordinarily possible if not easy to compute the actual relative orbit of the system—that is, the path of one assuming that the other is stationary. Dr. Strand's work differed from the more usual exercises of this type in that his measures were made from photographs. This eliminated some of the difficulties usually encountered in visual observation, and supplied a number of others; but there was a net gain in overall accuracy, to the extent that he was not only able to publish a more accurate set of orbital elements than had previously been available, but to show that the orbital motion was not regular.

The fainter star, it seemed, did *not* move around the brighter in a smooth ellipse at a rate predictable by the straightforward application of Kepler's laws. It did, however, move in a Keplerian path about an invisible point which was in turn traveling in normal fashion about the other sun.

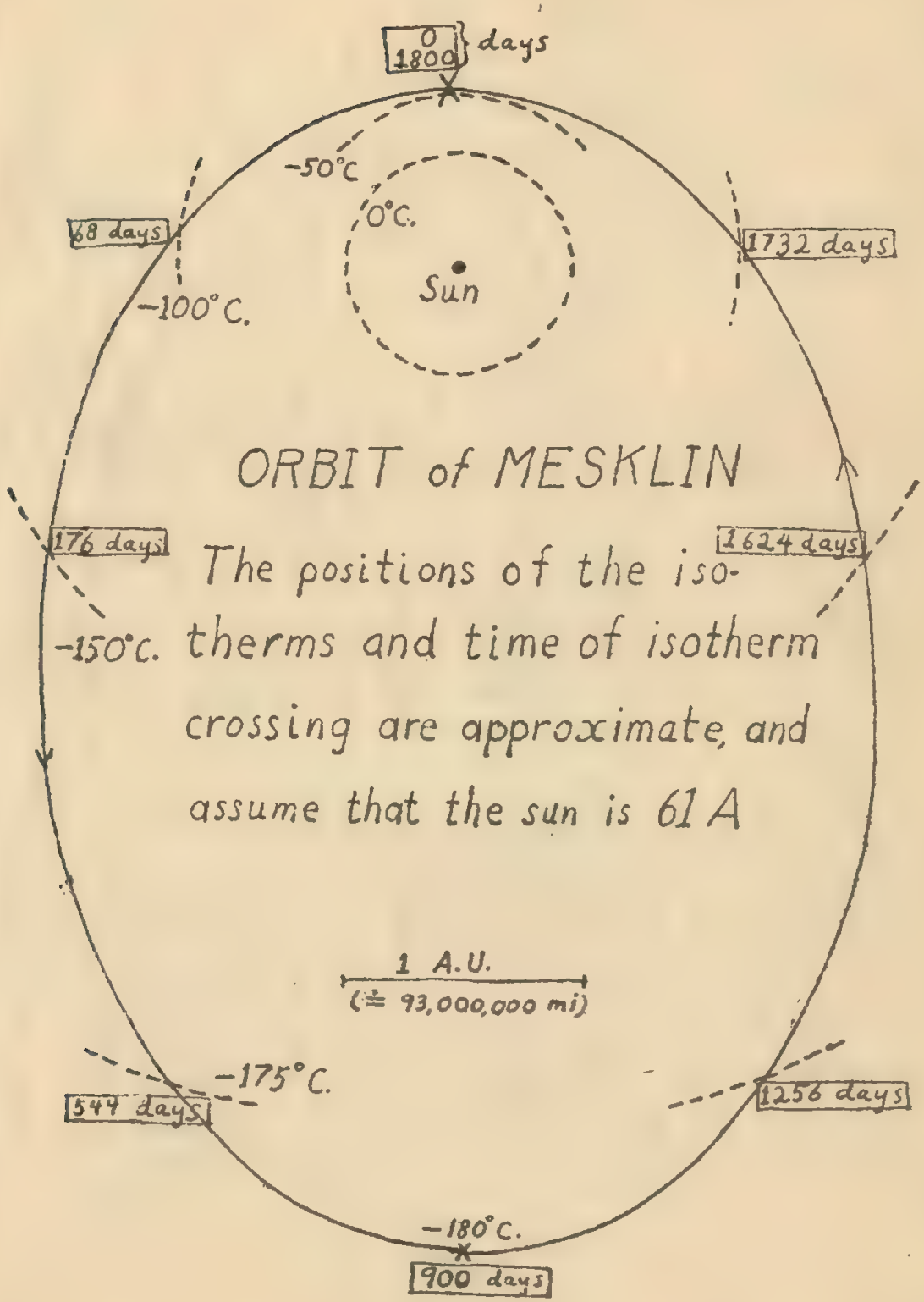
There was nothing intrinsically surprising about this discovery; the implication was plain. One of the two stars—it was not possible to tell which, since measures had been made *assuming* the brighter to be stationary—was actually accompanied by another, invisible object; the invisible point which obeys the normal planetary and stellar laws was the center of gravity of the star-unknown object system. Such cases are by no means unusual.

To learn which of the two suns is actually attended by this dark body, we would have to have more observations of the system, made in relation to one or more stars not actually part thereof. Some stars exist near enough to the line of sight for such observations to be made, but if they have been reduced and published the fact has not come to my attention. I chose to assume that the object actually circles the brighter star. That may cost me a point in the game when the facts come out, but I won't be too disheartened if it does.

There was still the question of just what this object was. In other such cases where an invisible object betrayed its presence by gravity or eclipse, as in the system of Algol, we had little difficulty in showing that the companion was a star of some more or less normal type—in the case of Algol, for example, the "dark" body causing the principal eclipse is a sun larger, hotter, and brighter than our own; we can tell its size, mass, luminosity, and temperature with very considerable precision and reliability.

In the case of the 61 Cygni system, the normal methods were put to work; and they came up immediately with a disconcerting fact. The period and size of the orbit, coupled with the fairly well-known mass of the visible stars, indicated that the dark body has a mass only about sixteen thousandths that of the sun—many times smaller than any star previously known. It was still about sixteen times the mass of Jupiter, largest planet we knew. Which was it—star or planet? Before deciding on the classification of an object plainly very close to the borderline, we must obviously decide just where the borderline lies.

For general purposes, our old grade-school distinction will serve; a star shines by its own light, while a planet is not hot enough for that and can be seen only by reflected light from some


0
1800
days
-50°C.
0°C.
Sun
68 days
1732 days
-100°C.
ORBIT of MESKLIN
176 days
1624 days
-150°C.
The positions of the isotherms and time of isotherm crossing are approximate, and assume that the sun is 61 A
1 A.U.
(≐ 93,000,000 mi)
-175°C.
544 days
1256 days
-180°C.
900 days

other source. If we restrict the word "light" to mean radiation we can see, there should be little argument, at least about definitions. (If anyone brings up nontypical stars of the VV_2 Cephei or $Epsilon_2$ Aurigae class I shall be annoyed.) The trouble still remaining is that we may have some trouble deciding whether this Cygnus object shines by intrinsic or reflected light, when we can't see it shine at all. Some educated guessing seems in order.

There is an empirical relation between the mass of a star, at least a main-sequence star, and its actual brightness. Whether we would be justified in extending this relation to cover an object like 61 Cygni C—that is, third brightest body in the 61 Cygni system—is more than doubtful, but may be at least suggestive. If we do, we find that its magnitude as a star should be about twenty or a little brighter. That is within the range of modern equipment, *provided* that the object is not too close to the glare of another, brighter star and *provided* it is sought photographically with a long enough exposure. Unfortunately, 61 C will never be more than about one and a half seconds of arc away from its primary, and an exposure sufficient to reveal the twentieth magnitude would burn the image of 61 A or B over considerably more than one and a half seconds' worth of photographic plate. A rotating sector or similar device to cut down selectively on the light of the brighter star might do the trick, but a job of extraordinary delicacy would be demanded. If anyone has attempted such a task, I have not seen his published results.

If we assume the thing to be a planet, we find that a disk of the same reflecting power as Jupiter and three times his diameter would have an apparent magnitude of twenty-five or twenty-six in 61 C's location; there would be no point looking for it with present equipment. It seems, then, that there is no way to be sure whether it is a star or a planet; and I can call it whichever I like without too much fear of losing points in the game.

I am supposing it to be a planet, not only for story convenience but because I seriously doubt that an object so small could maintain at its center the temperatures and pressures necessary for sustained nuclear reactions; and without such reactions no object could maintain a significant radiation rate for more than a few million years. Even as a planet, though, our object has characteristics which will call for thought on any author's part.

Although sixteen times as massive as Jupiter, it is *not* sixteen times as bulky. We know enough about the structure of matter now to be sure that Jupiter has about the largest volume of any possible "cold" body. When mass increases beyond this point, the central pressure becomes great enough to force some of the core matter into the extremely dense state which we first knew in white dwarf stars, where the outer electronic shells of the atoms can no longer hold up and the nuclei crowd together far more closely than is possible under ordinary—to us, that is—conditions. From the Jupiter point on up, as mass increases the radius of a body decreases—and mean density rises enormously. Without this effect—that is, if it maintained Jupiter's density with its own mass—61C would have a diameter of about two hundred fifteen thousand miles. Its surface gravity would be about seven times that of the Earth. However, the actual state of affairs seems to involve a diameter about equal to that of Uranus or Neptune, and a surface gravity over three hundred times what we're used to.

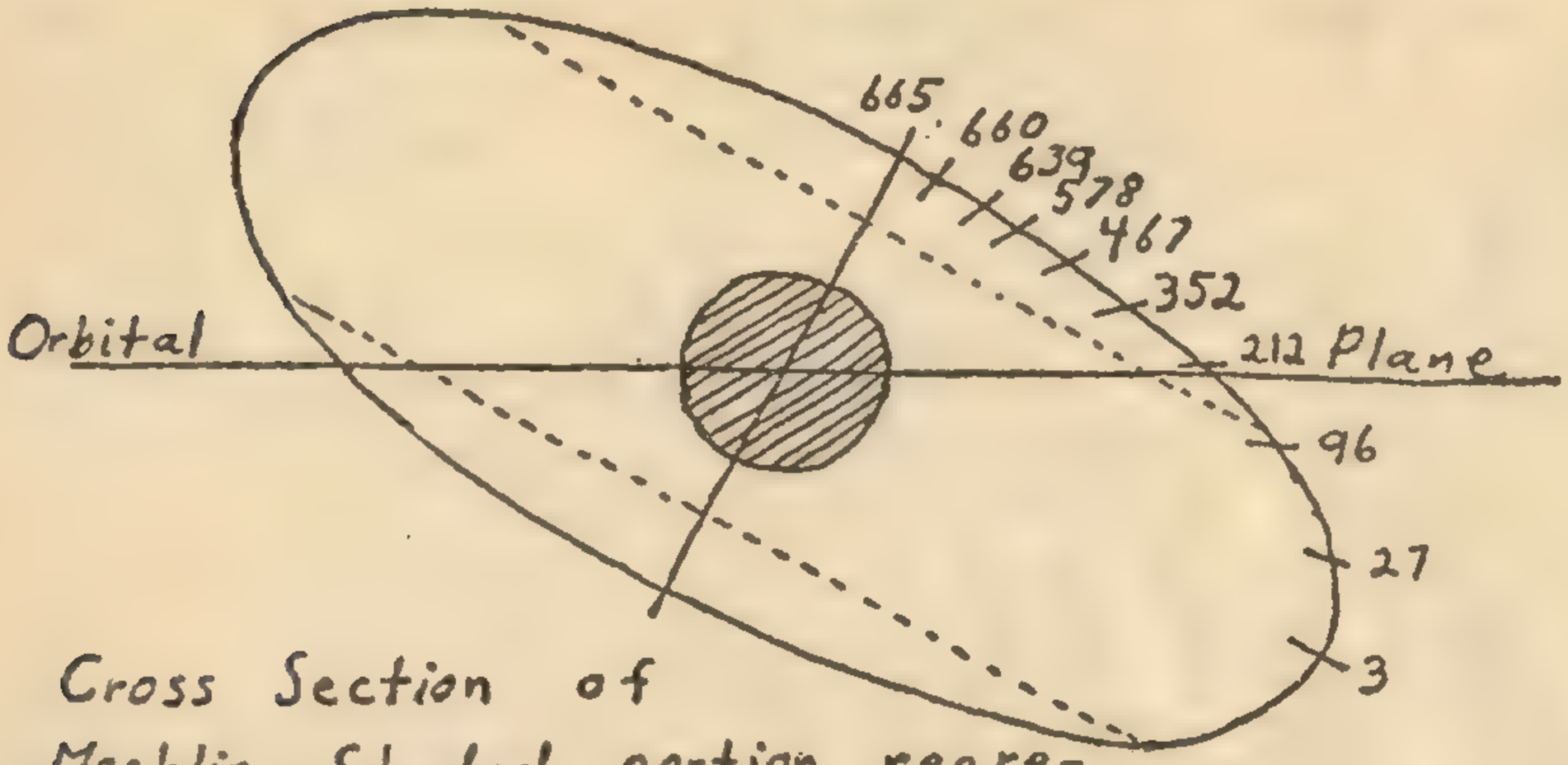
Any science fiction author can get around that, of course. Simply invent a gravity screen. No one will mind little details like violation of the law of conservation of energy, or the difference of potential across the screen which will prevent the exchange of anything more concrete than visual signals; no one at all. No one but Astounding readers, that is; and there is my own conscience, too. I might use gravity screens if a good story demanded them and I could see no legitimate way out; but in the present case there is a perfectly sound and correct means of reducing the effective gravity, at least for a part of a planet's surface. As Einstein says, gravitational effects cannot be distinguished from inertial ones. The so-called centrifugal force is an inertial effect, and for a rotating planet happens to be directed outward—in effect—in the equatorial plane. I can, therefore, set my planet spinning rapidly enough to make the characters feel as light as I please, at least at the equator.

If that is done, of course, my nice new world will flatten in a way that would put Saturn to shame; and there will undoubtedly be at least one astronomer reading the story who will give me the raised eyebrow if I have it squashed too little or too much. Surely there is some relation between mass, and rate of spin, and polar flattening—

I was hung up on that problem for quite a while. Since I had other things to do, I didn't really concentrate on it; but whenever a friend whose math had not collapsed with the years crossed my path, I put it up to him. My own calculus dissolved in a cloud of rust long, long ago. I finally found the answer—or *an* answer—in my old freshman astronomy text, which is still in my possession. I was forcibly reminded that I must also take into account the internal distribution of the planet's mass; that is, whether it was of homogeneous density or, say, almost all packed into a central core. I chose the latter alternative, in view of the enormous density almost certainly possessed by the core of this world and the fact that the outer layers where the pressure is less are presumably of normal matter.

I decided to leave an effective gravity of three times our own at the equator, which fixed one value in the formula. I had the fairly well known value for the mass, and a rough estimate of the volume. That was enough. A little slide rule work gave me a set of characteristics which will furnish story material for years to come. I probably won't use it again myself—though that's no promise—and I hereby give official permission to anyone who so desires to lay scenes there. I ask only that he maintain reasonable scientific standards, and that's certainly an elastic requirement in the field of science fiction.

The world itself is rather surprising in several ways. Its equatorial diameter is forty-eight thousand miles. From pole to pole along the axis it measures nineteen thousand seven hundred and forty, carried to more significant figures than I have any right to. It rotates on its axis at a trifle better than twenty degrees a minute, making the day some seventeen and three-quarter minutes long. At the equator I would weigh about four hundred eighty pounds, since I hand-picked the net gravity there; at the poles, I'd be carrying something like sixty tons. To be perfectly frank, I don't know the exact value of the polar gravity; the planet is so oblate that the usual rule for spheres, to the effect that one may consider all the mass concentrated at the center for purposes of computing surface gravity, would not even be a good approximation if this world were of uniform



Cross Section of Mesklin. Shaded portion represents Earth on same scale. Dotted lines are arctic and antarctic circles. Listed values of gravity (effective), represented by numbers at appropriate latitudes, are very approximate.

density. Having it so greatly concentrated helps a great deal, and I don't think the rough figure of a little under seven hundred Earth gravities that I used in the story is too far out; but anyone who objects is welcome if he can back it up. (Some formulae brought to my attention rather too late to be useful suggest that I'm too high by a factor of two; but whose formulae are the rougher approximations I couldn't guess—as I have said, my math has long since gone to a place where I can't use it for such things. In any case, I'd still stagger a bit under a mere thirty tons.)

I can even justify such a planet, after a fashion, by the current (?) theories of planetary system formation. Using these, I assume that the nucleus forming the original protoplanet had an orbit of cometary eccentricity, which was not completely rounded out by collisions during the process of sweeping up nearly all the raw material in the vicinity of its sun. During the stage when its "atmosphere" extended across perhaps several million miles of space, the capture of material from orbits which were in general more circular than its own would tend to give a spin to the forming world, since objects from outside its position at any instant would have a lower velocity than those from farther in. The rotation thus produced, and increased by conservation of angular momentum as the mass shrank, would be in the opposite direction to the world's orbital motion. That does not bother me, though; I didn't even mention it in the story, as nearly as I can now recall.

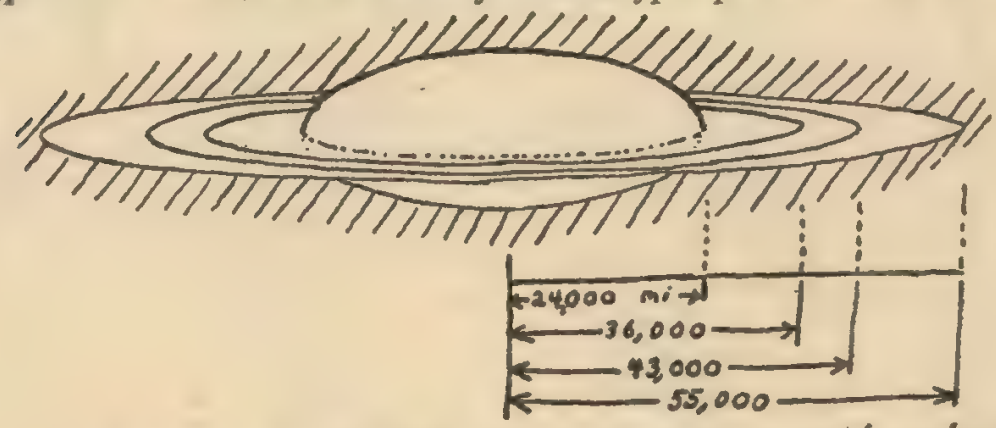
The rate of spin might be expected to increase to the point where matter was actually shed from the equator, so I gave the planet a set of rings and a couple of fairly massive moons. I checked the sizes of the rings against the satellite orbits, and found that the inner moon I had invented would produce two gaps in the ring similar to those in Saturn's decoration. The point never became important in the story, but it was valuable to me as atmosphere; I had to have the picture

clearly in mind to make all possible events and conversations consistent. The inner moon was ninety thousand miles from the planet's center, giving it a period of two hours and a trifle under eight minutes. The quarter-period and third-period ring gaps come about twelve and nineteen thousand miles respectively from the world's surface. The half-period gap would fall about thirty-three thousand miles out, which is roughly where Roche's Limit would put the edge of the ring anyway. (I say roughly, because that limit depends on density distribution, too.)

On the whole, I have a rather weird-looking object. The model I have of it is six inches in diameter and not quite two and a half thick; if I added the ring, it would consist of a paper disk about fourteen inches in diameter cut to fit rather closely around the plastic wood spheroid. (The model was made to furnish something to draw a map on; I like to be consistent. The map was drawn at random before the story was written; then I bound myself to stick to the geographic limitations it showed.) I was tempted, after looking at it for a while, to call the story "Pancake in the Sky," but Isaac Asimov threatened violence. Anyway, it looks rather more like a fried egg.

There are a lot of characteristics other than size, though, which must be settled before a story can be written. Since I want a native life form, I must figure out just what conditions that form must be able to stand. Some of these conditions, like the temperature and gravity, are forced on me; others, perhaps, I can juggle to suit myself. Let's see.

Temperature depends, almost entirely, on how much heat a planet receives and retains from its sun. 61 Cygni is a binary system, but the two stars are so far apart that I needn't consider the other one as an influence on this planet's temperature; and the one which it actually circles is quite easy to allow for. Several years ago I computed, partly for fun and partly for cases like this, a table containing some interesting information for all the stars within five parsecs for which I could secure data. The information consists of items such as the distance at which an Earth-type planet would have to



Scale drawing of Mesklin and ring system. Inner ring reaches to less than 1,000 miles of planet's surface; gaps are of corresponding width.

revolve from the star in question to have the present temperatures of Earth, Venus, and Mars, and how long it would take a planet to circle the sun in question in each such orbit. For 61 Cygni A the three distances are about twenty-eight, thirty-nine, and sixty-nine million miles, respectively. As we have seen, 61C's orbit is reasonably well known; and it is well outside any of those three distances. At its closest—and assuming that the primary star is 61A—it gets almost near enough to be warmed to about fifty below zero, Centigrade. At the other end of its rather eccentric orbit Earth at least would cool to about minus one hundred eighty, and it's rather unlikely that this world we are discussing gets too much more out of the incoming radiation. That is a rather wide temperature fluctuation.

The eccentricity of the orbit is slightly helpful, though. As Kepler's laws demand, the world spends relatively little time close to its sun; about four fifths of its year it is outside the minus one hundred fifty degree isotherm, and it is close enough to be heated above minus one hundred for only about one hundred thirty days of its eighteen-hundred-day year—Earth days, of course. Its year uses up around one hundred forty-five thousand of its own days, the way we've set it spinning. For practical purposes, then, the temperature will be around minus one hundred seventy Centigrade most of the time. We'll dispose of the rest of the year a little later.

Presumably any life form at all analogous to our own will have to consist largely of some substance which will remain liquid in its home planet's temperature range. In all probability, the substance in question would be common enough on the planet to form its major liquid phase. If that is granted, what substance will meet our requirements?

Isaac Asimov and I spent a pleasant evening trying to find something that would qualify. We wanted it not only liquid within our temperature limits, but a good solvent and reasonably capable of causing ionic dissociation of polar molecules dissolved in it. Water, of course, was out; on this world it is strictly a mineral. Ammonia is almost as bad, melting only on the very hottest days. We played with ammonia's analogues from further along the periodic table—phosphine, arsine, and stibine—with carbon disulfide and phosgene, with carbon suboxide and hydrogen fluoride, with saturated and unsaturated hydrocarbons both straight and with varying degrees of chlorine and fluorine substitution, and even with a silicone or two. A few of these met the requirements as to melting and boiling points; some may even have caused dissociation of their solutes, though we had no data on that point for most. However, we finally fell back on a very simple compound.

It boils, unfortunately, at an inconveniently low temperature, even though we assume a most unlikely atmospheric pressure. It cannot be expected to be fruitful in ions, though as a hydrocarbon it will probably dissolve a good many organic substances. It has one great advantage, though, from my viewpoint; it would almost certainly be present on the planet in vast quantities. The substance is methane—CH_4.

Like Jupiter, this world must have started formation with practically the "cosmic" composition, involving from our viewpoint a vast excess of hydrogen. The oxygen present would have combined with it to form water; the nitrogen, to form ammonia; the carbon to form methane and perhaps higher hydrocarbons. There would be enough hydrogen for all, and plenty to spare—light as it is, even hydrogen would have a hard time escaping from a body

having five thousand times the mass of Earth once it had cooled below red heat—at first, that is. Later, when the rotational velocity increased almost to the point of real instability, it would be a different story; but we'll consider that in a moment. However, we have what seems to be a good reason to expect oceans of methane on this world; and with such oceans, it would be reasonable to expect the appearance and evolution of life forms using that liquid in their tissues.

But just a moment. I admitted a little while ago that methane boils at a rather lower temperature than I wanted for this story. Is it *too* low? Can I raise it sufficiently by increasing the atmospheric pressure, perhaps? Let's see. The handbook lists methane's critical temperature as about minus eight-two degrees Centigrade. Above that temperature it will always be a gas, regardless of pressure; and to bring its boiling point up nearly to that value, a pressure about forty-six times that of our own atmosphere at sea level will be needed. Well, we have a big planet, which should have held on to a lot of its original gases; it ought to have a pressure of hundreds or even thousands of atmospheres—whoops! we forgot something.

At the equator, *effective* gravity—gravity minus centrifugal effect—is three times Earth normal. That, plus our specification of temperature and composition of the atmosphere, lets us compute the rate at which atmospheric density will decrease with altitude. It turns out that with nearly pure hydrogen, three g's, and a temperature of minus one hundred fifty for convenience, there is still a significant amount of atmosphere at six hundred miles altitude if we start at forty-odd bars for surface pressure—*and at six hundred miles above the equator of this planet the centrifugal force due to its rotation balances the gravity!* If there had ever been a significant amount of atmosphere at that height, it would long since have been slung away into space; evidently we cannot possibly have a surface pressure anywhere near forty-six atmospheres. Some rough slide-rule work suggests eight atmospheres as an upper limit—I used summer temperatures rather than the annual mean.

At that pressure methane boils at about minus one hundred forty-three degrees, and for some three hundred Earth days, or one sixth of each year, the planet will be in a position where its sun could reasonably be expected to boil its oceans. What to do?

Well, Earth's mean temperature is above the melting point of water, but considerable areas of our planet are permanently frozen. There is no reason why I can't use the same effects for 61C; it is an observed fact that the axis of rotation of a planet can be oriented so that the equatorial and orbital planes do not coincide. I chose for story purposes to incline them at an angle of twenty-eight degrees, in such a direction that the northern hemisphere's midsummer occurs when the world is closest to its sun. This means that a large part of the northern hemisphere will receive no sunlight for fully three quarters of the year, and should in consequence develop a very respectable cap of frozen methane at the expense of the oceans in the other hemisphere. As the world approaches its sun the livable southern hemisphere is protected by the bulk of the planet from its deadly heat output; the star's energy is expended in boiling off the north polar "ice" cap. Tremendous storms rage across the equator carrying air and methane vapor at a temperature little if any above the boiling point of the latter; and while the southern regions will warm up during their winter, they

should not become unendurable for creatures with liquid methane in their tissues.

Precession should be quite rapid, of course, because of the tremendous equatorial bulge, which will give the sun's gravity a respectable grip even though most of the world's mass is near its center. I have not attempted to compute the precessional period, but if anyone likes to assume that a switch in habitable hemispheres occurring every few thousand years has kept the natives from building a high civilization I won't argue. Of course, I will also refrain from disagreement with anyone who wants to credit the periodic climate change with responsibility for the development of intelligence on the planet, as our own ice ages have sometimes been given credit for the present mental stature of the human race. Take your pick. For story purposes, I'm satisfied with the fact that either possibility can be defended.

The conditions of the planet, basically, are pretty well defined. There is still a lot of detail work. I must design a life form able to stand those conditions—more accurately, to regard them as ideal—which is not too difficult since I don't have to describe the life processes in rigorous detail. Anyone who wants me to will have to wait until someone can do the same with our own life form. Vegetation using solar energy to build up higher, unsaturated hydrocarbons and animal life getting its energy by reducing those compounds back to the saturated form with atmospheric hydrogen seemed logical enough to me. In the story, I hinted indirectly at the existence of enzymes aiding the reduction, by mentioning that plant tissues would burn in the hydrogen atmosphere if a scrap or two of meat were tossed onto the fuel.

The rest of the detail work consists of all my remaining moves in the game—finding things that are taken for granted on our own world and would not be true on this one. Such things as the impossibility of throwing, jumping, or flying, at least in the higher latitudes; the tremendously rapid decrease of air density with height in the same regions, producing a mirage effect that makes the horizon seem *above* an observer all around; the terrific Coriolis force that splits any developing storm into a series of relatively tiny cells—and would make artillery an interesting science if we could have any artillery; the fact that methane vapor is denser than hydrogen, removing a prime Terrestrial cause of thunderstorm and hurricane formation; the rate of pressure increase below the ocean surface, and what that does to the art of navigation; the fact that icebergs won't float, so that much of the ocean bottoms may be covered with frozen methane; the natural preference of methane for dissolving organic materials such as facts rather than mineral salts, and what that will do to ocean composition—maybe icebergs *would* float after all. You get the idea.

The trouble was, I couldn't possibly think of all these things in advance; time and again a section of the story had to be rewritten because I suddenly realized things couldn't happen that way. I must have missed details, of course; that's where your chance to win the game comes in. I *had* an advantage; the months during which in my spare hours, my imagination roamed over Mesklin's vast areas in search of inconsistencies. Now the advantage is yours; I can make no more moves in the game, and you have all the time you want to look for the things I've said which reveal slips on the part of my imagination.

Well, good luck—and a good time, whether you beat me or not.

BRASS TACKS

Dear Mr. Campbell:

Re your editorial on "Unsane Behavior" in the March 1953 issue. Your arguments may be true for mankind as a whole. Your arguments are reasonable for individuals. But when you draw one premise from individual behavior and then apply it to the behavior of all mankind, you are performing the trick of adding together two dissimilar objects. The statement that man has tried out wars for seven thousand years is meaningless. Certainly no one individual has done so.

It is agreed that all animal life can learn after an ADEQUATE number of tries. The term ADEQUATE can be determined for an individual. History has shown that it has not been determined for mankind as a whole.

Surely it is impossible for mankind to pass its experiences on through the ages in an unbroken chain. History may endure, but an individual's experiences end with his death. Consider the father trying to ingrain wisdom in his son. Can it be done? Surely you will agree that there are difficulties. The son must gain experience for himself. Consider the raising of children. It has been my experience that the first child is the most difficult to rear. After the first, experience steps in to help. But according to your premises, I should have learned how to raise children from my parents, or friends, or books. Believe me, it just can't be done. No matter how many times something has occurred to others, it will help only slightly the individual that is experiencing it himself for the first time.

Your claim that war does not work is again a case of confusing the individual with the whole. Certainly war does not work for mankind as a whole. That fact is self-evident. But just as certainly war does work for an individual. The great Khan did not do so badly for himself.

The arguments about horse-stealing and pickpockets are again a matter of confusing the forest with the tree. If a tree becomes rotten, it is cut down. That quite effectively disposes of THAT tree and prevents it from ever

becoming rotten again. But how about the forest? It has many trees, none of which learned from the tree that was destroyed. Each and every tree can also rot. The forest never seems to learn, although the trees do.

Fear can and does inhibit an individual. Approximately one hundred people are killed in traffic accidents every day in the United States. Yet people still go out and break every rule in the book just to gain a few minutes time on the road. Those hundred deaths do not act as a deterrent to an individual unless he has been affected personally. But let a man have a near escape from death and note how carefully he will drive for a while. Incidentally, just imagine how many accidents there would be if there were no laws governing traffic on the highways. Surely the fear of getting caught inhibits many drivers.

Just because we have always had wars does not mean that wars will continue forever. But apparently the adequate number of tries that it takes Mankind to learn has not been reached. Let us hope that the number is not infinite.

How about it? Individuals can learn, the Human Race cannot.—Morris A. Arkin, 2581 Hilyard Street, Eugene, Oregon.

The life-forms below the mammalia communicate from individual-to-individual only *genetically. Snakes don't learn as individuals, and can't learn from other snakes' experience. Trees can't, either. Mammals do learn, and so some individual-to-individual communication and learning takes place. Man has a characteristic that makes him more-than-mammalian; speech. He* can *learn non-genetically. Problem: When he* can *why is it he* doesn't?

Dear Mr. Campbell:

This is rather late, but I just wished to put in my minor bit of praise for "Null ABC" . . . a wonderful way to start the year! The authors should be congratulated for writing it and you for printing it.

The teachers' college I attend is trying—vainly—to instill me with an affection for the teaching methods mentioned in "Null ABC"; unfortunately, there is a laboratory school on campus which uses the techniques of "progressive education" . . . the results are not very encouraging—they are perhaps the most powerful condemnation of the system anyone could hope for. Again, the highest praise a future teacher—I hope—can give for "Null ABC" and for Astounding.

1. Null ABC
2. Nightmare Brother
3. Crucifixus Etiam
4. The Cog
5. Safety Valve
6. For the Glory of Agon—J. R. Wellons.

Maybe you'll particularly like Professor Arnold's article in the May issue.

Dear Mr. Campbell:

It proved a little hard to decide which of the stories I liked best in the February issue—that is, after I set "The Cog" aside. I finally constructed a sort of rating chart and placed them thus:

1. The Cog
2. Null ABC, part I
3. Crucifixus Etiam
4. For the Glory of Agon
5. Safety Valve
6. Nightmare Brother

They were grouped very closely.

Mr. Fritch's sketch, "The Cog," I think, is one of those rare little jewels. Of course, it's not a story, really. It's

just a short incident. But it tells a big story. It's the final distillation of a long story, and it serves as a perfect illustration of the editorial—or is the editorial a perfect explanation of "The Cog"? I'd say Mr. Fritch's redundancy is on the order of 0.1 here.

My biggest objection to "Null ABC" is its high probability. Here is one of those stories that could happen, and it scares me a little. That, I realize, is no valid objection at all, but the fact remains that the first installment made me look at my own children with just a little twinge of apprehension. I think I can keep *them* from neglecting their studies for the radio and TV sets, but how about their youngsters—and theirs?—Everett B. Cole.

The greatest service science-fiction can render, it seems to me, is to point out the probable results of present trends —and then let the reader decide whether that's what he wants!

Dear Sir:

I have been reading ASF for thirteen years now—quite steadily, and with increasing pleasure. I have collected the magazine for the last eight years, and I have many copies dating from before that. And I take a lot of pleasure in re-reading issues time and time again. But all that is just to set the stage for what I want to talk to you about.

In reading and re-reading ASF, I am constantly struck with the vast contempt in which a large percentage of your authors hold what they call "politicians." Now I am not a disinterested observer, since, in addition to teaching college courses in political science, I am also an active politician. Or at least, I take considerable pride in thinking that I am. I have served on campaign committees in varying capacities of much greater activity than the usual volunteer worker. During the recent presidential campaign, I served full time (14–20 hrs per day, 7 days per week—no exaggeration!) with the state headquarters of one political party in a state which will be unnamed. (Incidentally, we lost.) So, I think I can speak in defense of *homo candidatensis*.

First, so many of your authors merely repeat the common canards about us ward-heelers. We are corrupt, we are ignorant, we have no ideals, we are meddling in things which do not concern us. From my vantage point on a college faculty, I think I can say that politicians are at least as ethical and idealistic and informed as any other professional group in our society. But that leaves the last mentioned objection.

It is commonplace for your authors, who either are, or share the viewpoint of, technicians in the sciences, to contend that "politicians" have no business attempting to regulate the use of, let us say, atomic power, or any of a number of other new segments of the 20th Century Scientific Revolution. Their arguments are based upon the notion that "politicians" are just not trained in scientific fields, and that, therefore, they should leave these matters to those properly trained.

But are "scientists" better trained in the *control*, let us say of atomic energy? After all, in this matter of control, we are attempting to fit atomic power into a world complex of an almost infinite number of other facts. Atomic energy is a fact. O.K. The existence of things called Communism, Democracy, patriotism, and so on *ad nauseam* are also facts. Unpleasant or pleasant facts, but facts. It is the business of politicians to adjust a large number of differing facts, and a larger number of differing

attitudes toward these facts, into some kind of solution—some compromise which will not satisfy everyone, but will offend as few people to as small a degree as possible. You say, "But this solution may be objectively the wrong one." True, but one thing politicians discover is that this kind of solution is the only one which will ever work, since any workable solution is so, only to the extent that it receives popular co-operation. This is true in a democracy, or in a dictatorship. It would even be true in the hypothetical scientist-run state. A government which operates along a line of action which is objectively correct, but highly unpopular, is not going to be effective. "Teach people to recognize their own best interests, and to accept unpalatable but necessary lines of action," runs your reply. Fine. When this is done—and more is being done along these lines than we sometimes realize—then we *may* be able to do away with the need for compromise. Personally, I doubt it. Even when people can see more clearly through slogans and shibboleths, there will still remain objective differences of interest which will make every solution of every problem less inclined to please Group A than Group B.

I agree that scientists should run the technical phases of nuclear research, and of all other aspects of society which are at present amenable to the formally recognized sciences. I also insist, however, that political technicians—"politicians" if you will—are more able to solve the problems of synthesis of interests than are any other kind of technicians. You complain that scientists are told to mind their own business when they look into political questions. In general, this has only been true when scientists have leaned upon their scientific reputations to make improbable suggestions for the solution of political problems. Oh, sure, members of the lunatic fringe of our profession automatically suspect anyone with a Ph.D. of subversive leanings. But, by and large, we politicians are willing to accept technical advice in technical fields from those generally recognized as competent to give it. Our own profession is remarkably open. The only qualification for entrance is electability, which usually means a well-developed ability to achieve the synthesis I was talking about above.

To boil my argument down, I merely want to suggest that human affairs are not irrevocably lost by being placed in the hands of "politicians." I would like to have been able to put this into a novelette, but this I will leave to some one of your writers who would like to handle it. Incidentally, now that I think about it, Asimov did something with the notion back in 1945, in a short story called "Blind Alley." I wish someone would do something with it today.—James B. Harrison.

The politician is suspect, I think, for the same reason as the magician. Each may be a highly trained technician in a highly skilled field, but most people can't see what the field is. *It's the bystander who is ignorant, in this case, not the politician. The truth of Harrison's point on the futility of a ruling the population doesn't like is nowhere better shown than by the unlamented Eighteenth Amendment.*

Let us be scientific; if a theory won't work, no matter how pretty its logic, how desirable its intended end —efforts to enforce it are not . . . politic!

Dear Mr. Campbell:

An electrical engineering student speculates on the February editorial.

Given a data-set, and given a fractional-redundance computer. The computer could derive new facts from the given data-set. A low-redundance computer could derive more facts than a high-redundance one. As the redundance approaches zero, the number of derivable facts increases without limit. A zero-redundance computer would then be pure cause.

Assume a data-set such that, if it were given to a zero-redundance computer, the computer could derive all facts, past and future. Then that data-set would contain ultimate cause. Ultimate cause might be defined verbally as the smallest data-set which would allow a zero-redundance computer to derive from it all facts.

Some information is lost in defining and manipulating a pure concept in terms of any finite symbology such as words. The data handling system of a zero-redundance computer would not be physical, since it would have to manipulate pure concepts. Conversely, a system which manipulates pure concepts would be, at least in part, non-physical.

Which raises a question. Can a computer decrease its own redundance? If so, how? What is the lower limit? If this lower limit is zero, a computer might lead itself to ultimate cause. Needed: a definition of "pure concept."—Phil Binstock, 1650 Upton Avenue North, Minneapolis 11, Minnesota.

In other words, a fractional-redundance computer would give out more than was put in it; it would, like a human mind, be capable of creative thinking.

FOOD FOR THOUGHT?

COMMUNIST philosophy: "A man has a right to what he produces."
Basic law of biology: "No organism can live in a medium of its own products."
Conclusion: Communism may be a good idea, but it won't work.

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MISSION OF GRAVITY

By HAL CLEMENT

Third of four parts. *At four gravities, there are things you can get away with; on Mesklin, where an appalling seven hundred gravities waited—things didn't work out the same! Now that canoe . . . What's wrong?*

Illustrated by van Dongen

SYNOPSIS

For the first time in history, the scientists of Earth and the planets of nearby stars have acquired the opportunity to make studies of a really intense gravitational field. The solitary planet of the brighter component of the binary star 61 Cygni has a mass some five thousand times that of Earth, but because it consists largely of degenerate matter has a volume not much larger than that of Uranus. Ordinarily this would mean a surface gravity of about three hundred times that of Earth, and for several similar worlds this has been the case; but the 61 Cygni planet has such an enormously rapid rotation rate that, while its effective equatorial gravity is only three times that of Earth, the extreme flattening gives it well over six hundred G's at the poles.

Recognizing the opportunity, the governments of several planets pool resources and construct a special research rocket which will be capable of landing in those polar regions without destruction, and load it with as much varied apparatus as their scientists can devise. Under remote control, the rocket lands at the south pole of the giant planet, presumably secures its data—but fails to respond to the take-off signal. Some of the data was telemetered, but some

is on records that must be physically recovered; and no known living creature can survive in the gravity of the polar regions.

However, a station is built at the equator to do what can be done; and Charles Lackland, while conducting xenological investigations near the dome, encounters Barlennan, a native of the world, which he calls Mesklin.

Barlennan is the captain and owner of a tramp ship, half trader and, Lackland suspects, half pirate, exploring the almost unknown equatorial zone of the world. He has beached his ship, the Bree, *near the station for the season; Mesklin is approaching periastron, which is also the northern hemisphere's midsummer, and the boiling of the cap of frozen methane which has built up around the northern pole during the preceding four Earth-years creates tremendous storms which render the seas impassable. Lackland and Barlennan form a friendship, partly because each sees a chance of obtaining what he wants from the other and partly because of natural sympathy. The Mesklinite, over a period of several weeks, learns a great deal of Lackland's language, and a tentative agreement is reached whereby Barlennan is to make the thirty-thousand-mile voyage to the south pole, find the grounded rocket, and transmit its information by a specially designed radio-television unit which the scientists of the expedition devise to withstand Mesklin's cold, pressure, and gravity—it is a solid block of material, using only printed circuits, transistors, and similar non-living parts. In return the expedition is to furnish weather predictions for Barlennan until he returns to his own country, thus enabling him to carry safely a far larger cargo.*

The trip cannot be started until the beginning of spring in the southern hemisphere, and in the interval it is discovered through the examination of photographs made from space that the downed rocket is very awkwardly located—an overland journey of several thousand miles will be needed for the Bree's *crew to reach it. Another body of "water" also reaches the south polar regions, and a river feeding it passes within a few miles of their goal; but no navigable passage to this second sea can be found on the photographs. However, an incident which occurs when Lackland and Barlennan are exploring some miles from the station gives the latter an idea. The tank in which they are riding is crippled, and the Earthman's cumbersome armor makes it impossible for him to reach the dome in the triple gravity; but the crew of the* Bree *is able to tow him back on a sled made of metal from the wrecked tank. Barlennan now suggests that a similar sled be made for his ship, and towed to the other ocean by another tank.*

This proves feasible, as the ocean extends into the low-gravity regions of the equator where Lackland can survive to operate the tank. The route is laid out with the aid of more aerial photographs, the sled constructed at the main expedition base on Toorey, Meklin's inner moon, and ferried to the equatorial station. As winter draws to a close, the Bree *is loaded aboard—the ship is only forty feet in length, and easily carried by her crew in their present near-weightless environment—and the trip starts.*

Barlennan, through a misunderstanding of Lackland's, has already had an experience which has jarred out of him the ingrained, conditioned fear of height characteristic of all natives of his part of the planet—a fear amply justified by the savage gravitation under which they live, which makes a fall of even half their eighteen-inch body length almost certainly fatal. The very idea of a fall is strange to them; in their land, an object released at a height simply disappears, to reappear almost simultaneously on the ground below in a well flattened state.

During the journey the crew is also forced to defy this conditioning; while trading in a strange city discovered en route, they are attacked by the natives, whose method of assault consists of rolling large rocks from the hill completely encircling the town. The only escape for the Mesklinites is by jumping or climbing to the tank's roof; the vehicle itself is saved by destroying with high-explosive shells the only rock in a position to do it serious damage. After this, the Mesklinites become almost comically defiant of their old fears, jumping and climbing with what amounts to recklessness and causes Barlennan some concern.

The journey is continued, and is almost at its end when the tank encounters an apparently insuperable obstacle—a cliff some sixty feet in height dropping away ahead of them, and extending as far as can be seen in either direction. The tank cannot possibly negotiate such a drop; and even in the relatively feeble gravity of the equatorial zone sixty feet is too much for the Mesklinites—and for their ship.

Further aerial reconnaissance indicates that the cliff extends much too far in both directions to be rounded, but that two rivers empty over its edge within reasonable distance of the tank's present position. The travelers proceed to one of these and, again at Barlennan's suggestion, the Bree *is disassembled and hoisted over the edge, together with her crew. The ship is quickly put together again by the river at the cliff's foot, and launched. She proceeds on her way alone, while Lackland, who has done all he could on Mesklin's surface, calls the rocket to take him back to Toorey.*

On the way downstream, Barlennan encounters savages of his own species and for the first time in his life sees a canoe. He is deeply impressed with the load-carrying powers of this strange, hollow boat—the Bree *is a collection of rafts bound together to combine strength with flexibility—and acquires one, dreaming of revolutionizing the maritime commerce of his nation.*

Part 3

XI.

On Earth, the land is the home of life. Marine biologists will say, quite warmly, that the sea swarms with living creatures; that it is, indeed, the cradle of life. Both of these statements are partly true. In the shallow, wave-beaten regions of the continental shelves life does indeed swarm; but much of it lives on the relatively tiny amount of detritus washed from the land. The broad seas that cover three fourths of the planet's surface, while by no means deserted, can hardly be compared with a section of Amazon jungle as a home for either flora or fauna. On Earth, the seas and rivers are of water; the material picked up by the latter and carried to the broad reservoirs of the oceans is largely inorganic, since water dissolves most effectively the inorganic salts of the continental masses. Substances usable as animal food are carried to the ocean as large, suspended particles, if at all.

Mesklin's principal liquid is methane. The fearful storms caused by the planet's seasonal extremes involve the evaporation and subsequent fall of vast quantities of this liquid; and as it rolls back to the oceans it picks up not the salts and minerals but the organic detritus of fats and similar compounds formed by the rather sparse life of the continental areas. This has gone on for a time comparable to the two billion years in which Earth's oceans have been collecting their salt; and the seas of Mesklin are in consequence almost like a laboratory broth for the culture of micro-organisms. On Earth the life of the sea depends largely on light;

the deep sea forms subsist basically on what falls from above. On Mesklin this is true also—but the relative amount of that fall is unbelievable. Animal life swarms in the seas of the giant world from surface to bottom—and the bottom forms, as Lackland already had reason to suspect, were the largest.

The *Bree* sailed into the eastern ocean so gradually that no one could say exactly when the change was made. The wind had picked up day by day until she had normal open-sea use of her sails; the river widened rod by rod and at last mile by mile until the banks were no longer visible from the deck. It was still "fresh water"—that is, it still lacked the swarming life that stained practically all the ocean areas in varying tints and helped give the world such a startling appearance from space—but the taste was coming, as sailor after sailor verified to his own great satisfaction.

Their course was still east, for a long peninsula barred their way to the south, according to the Flyers. Weather was good, and there would be plenty of warning of any change from the strange beings that watched them so carefully. There was plenty of food still aboard, enough to last easily until they reached the rich areas of the deep seas. The crew was happy.

Their captain was satisfied as well. He had learned, partly from his own examination and experiment and partly from Lackland's casual explanations, how it was that a hollow vessel like the canoe could carry so much more weight for its size than could a raft. He was already deep in plans for the building of a large ship—as big or bigger than the *Bree*—built on the same principle and able to carry the profits of ten voyages in one. Dondragmer's pessimism failed to shake his rosy dream; the mate felt that there must be some reason such vessels were not used by their own people, though he could not say what the reason might be.

"It's too simple," he kept pointing out. "Someone would have thought of it long ago if that's all there was to it." Barlennan would simply point astern, where the canoe now followed gayly at the end of a rope, laden with a good half of their food. The mate could not shake his head after the fashion of an old family coachman looking over the new horseless carriage, but he would certainly have done so if he had possessed a neck.

He brightened up when they finally swung southward, and a new thought struck him.

"Watch it sink as soon as we start to get a little decent weight!" he exclaimed. "It may be all right for the creatures of the Rim, but you need a good solid raft where things are normal."

"The Flyer says not," replied Barlennan. "You know as well as I do that the *Bree* doesn't float any higher here at the Rim than she does at home, or even near the center. The Flyer says it's because the water weighs less too, which sounds as though it might be reasonable." Dondragmer did not answer; he simply glanced, with an expression equivalent to a complacent smile, at the tough wood spring-balance and weight that formed one of the ship's principal navigating instruments. As that weight began to droop he was sure, something that neither his captain nor the distant Flyer had counted on would happen. He did not know what it would be, but he was certain of the fact.

The canoe, however, continued to float as the weight slowly mounted. It did not, of course, float as high as it would have on Earth, since liquid methane is less than half as dense as water; its "water" line, loaded as it was, ran approximately halfway up

from keel to gunwale, so that fully four inches were invisible below the surface. The remaining four inches of freeboard did not diminish as the days went by, and the mate seemed almost disappointed. Perhaps Barlennan and the Flyer were correct after all.

Weight slowly increased, from the three and a half Earth gravities at the river mouth to four, and then to five, and then to seven, with nothing to break the even tenor of the passing days. They were in open sea now, with fully two thousand miles of their southward journey accomplished. Their course had not always been directly south; every few days a message would come from the watchers above, directing them to swing one way or the other to take advantage of the winds. Mesklin's cyclones were tighter and faster moving than those of Earth, because of the planet's enormously greater rate of spin; even this close to the equator a single cell was seldom more than a few hundred miles across, and circulated usually at better than sixty miles an hour. The waves raised by these winds were high, but long and regular; they meant nothing to the crew of the *Bree*, who regarded much more violent weather as the norm. The unusual, and pleasant, fact about the present situation was to have both waves and wind almost constantly coming from astern. Evidently deals with the Flyers were worth while.

The spring balance was starting to show a barely visible sag from the zero position—it had been made, of course, for use where weight was scores or hundreds of times Earth-normal—when the monotony was broken. Actual weight was about seven Earth's. The usual call from Toorey was a little late, and both the captain and mate were beginning to wonder whether all the remaining radios had failed for some reason when it finally arrived. The caller was not Lackland, but a meteorologist the Mesklinites had come to know quite well.

"Barl," the weather man, opened without preamble, "I don't know just what sort of storm you consider too bad to be out in—I suppose your standards are pretty high—but there seems to be one coming that I certainly wouldn't want to ride out on a forty-foot raft. It's a tight cyclone, of what I would consider hurricane force even to Mesklin, and on the thousand-mile course I've been observing so far it has been violent enough to stir up material from below and leave a track of contrasting color on the sea."

"That's enough for me," Barlennan replied. "How do I dodge it?"

"That's the catch; I'm not sure. It's still a long way from your position, and I'm not absolutely sure it will cross your course just when you're at the wrong point. There are a couple of ordinary cyclones yet to pass you, and they will change your course some and possibly even that of the storm. I'm telling you now because there is a group of fairly large islands about five hundred miles to the southeast, and I thought you might like to head for them. The storm will certainly strike them, but there seems to be a number of good harbors where you could shelter the *Bree* until it was over."

"Can I get there in time? If there's serious doubt about it, I'd prefer to ride it out in the open sea rather than be caught near land of any sort."

"At the rate you've been going, there should be plenty of time to get there and scout around for a good harbor."

"All right. What's my noon bearing?"

The men were keeping close track

of the *Bree's* position by means of the radiation from the vision sets, although it was quite impossible to see the ship from beyond the atmosphere with any telescope. No one had worked out a really satisfactory co-ordinate system for describing position on the planet, but that was largely because no one liked anyone else's. Several were in use that were mathematically adequate, and the meteorologist had no trouble in giving the captain the bearing he wanted. The sails were adjusted accordingly and the *Bree* moved off on the new course. Her speed was somewhat lower, as she could take less advantage of the wind; but after Barlennan cast the log and reported the new value on the radio, he was assured that he would still have plenty of time.

The weather was still clear, though the wind was strong. The sun arched across the sky time after time without much change in either of these factors; but gradually a high haze began to appear and thicken, so that the sun changed from a golden disk to a rapidly moving patch of pearly light. Shadows became less definite, and finally vanished altogether as the sky became a single almost uniformly luminous dome. This change occurred slowly, over a period of many days, and while it was going on the miles kept slipping beneath the *Bree's* rafts, sometimes rapidly as the wind shifted to dead astern and sometimes more slowly as the sails were trimmed to take advantage of quartering breezes.

They were less than a hundred miles from the islands when the minds of the crew were taken off the matter of the approaching storm by a new matter. The color of the sea had shifted again, but that bothered no one; they were as used to seeing it blue as red. No one expected signs of land at this distance, since the currents set generally across their course and the birds which warned Columbus did not exist on Mesklin. Perhaps a tall cumulous cloud, of the sort which so frequently forms over islands, would be visible for a hundred miles or more; but it would hardly show against the haze that covered the sky. Barlennan was sailing by dead reckoning and hope, for the islands were no longer visible to the Earthmen overhead.

Nevertheless it was in the sky that the strange event occurred.

From far ahead of the *Bree*, moving with a swooping, dipping motion that was utterly strange to the Mesklinites and would have been perfectly familiar to the human beings, there appeared a tiny dark speck. No one saw it at first, and by the time they did it was too near and too high to be in the field of view of the vision sets. The first sailor to notice it gave vent to the usual hoot of surprise, which startled the human watchers on Toorey but was not particularly helpful to them. All they could see as their wandering attentions snapped back to the screens was the crew of the *Bree*, with the front end of every caterpillarlike body curled upward as its owner watched the sky.

"What is it, Barl?" Lackland called instantly.

"I don't know," the captain replied. "I thought for an instant it might be your rocket down looking for the islands to guide us better, but it's smaller and very different in shape."

"But it's something *flying?*"

"Yes. It does not make any noise like your rocket, however. I'd say it was being blown by the wind, except that it's moving too smoothly and regularly and in the wrong direction. I don't know how to describe it; it's wider than it is long, and a little bit like a mast set crosswise on a spar. I can't get closer than that."

"Could you angle one of the vision

sets upward so we could get a look at it?"

"We'll try." Lackland immediately put through a call on the station telephone for one of the biologists.

"Lance, it looks as though Barlennan had run into a flying animal of some sort. We're trying to arrange a look at it. Want to come down to the screen room to tell us what we're looking at?"

"I'll be right with you." The biologists voice faded toward the end of the sentence; he was evidently already on his way out of the room. He arrived before the sailors had the vision set propped up, but dropped into a chair without asking questions. Barlennan was speaking again.

"It's passing back and forth over the ship, sometimes in straight lines and sometimes in circles. Whenever it turns it tips, but nothing else about it changes. It seems to have a little body where the two sticks meet . . ." He went on with his description, but the object was evidently too far outside his normal experience for him to find adequate similes in a strange language.

Lance Beck, the biologist, voiced the thought that was in everyone's mind.

"I've been doubting all along that there could be any life form, except something of insect size, that could evolve into a flying creature in Mesklin's environment. The gravity is too high, the air only about half as dense as that of the Earth at sea level, and the storms too violent and long-lasting—no creature that did fly on Mesklin could afford to do without food very long, because of the enormous energy demands on its system. I wish that thing would fly in front of the scanner; when something makes me a liar I like to know why."

"If it does come into view, be prepared to squint," the voice of one of the technicians cut in. "I'm covering that screen with a high-speed camera, and will have to jump the brightness a good deal in order to get a decent exposure."

". . . There are smaller sticks set across the long one, and what looks like a very thin sail stretched between them. It's swinging back toward us again, very low now—I think it may come in front of your eye this time . . ."

The watchers stiffened, and the hand of the photographer tightened on a double-pole switch whose closing would activate his camera and step up the gain on the screen. Ready as he was, the object was well into the field before he reacted, and everyone in the room got a good glimpse before the suddenly bright light made their eyes close involuntarily. They all saw enough.

No one spoke while the cameraman energized the developing-frequency generator, rewound his film through its poles, swung the mounted camera toward the blank wall of the room, and snapped over the projection switch. Everyone had thoughts enough to occupy him for the fifteen seconds the operation required.

The projection was slowed down by a factor of fifty, and everyone could look as long as he pleased. There was no reason for surprise that Barlennan had been unable to describe the thing; he had never dreamed that such a thing as flying was possible until after his meeting with Lackland a few months before, and had no words in his own language for anything connected with the art. Among the few English words of that group he had learned, "fuselage" and "wing" and "empennage" were not included.

The object was not an animal. It had a body—fuselage, as the men

thought of it—some three feet long, half the length of the canoe Barlennan had acquired. A slender rod extending several feet rearward held control surfaces at its extremity. The wings spanned a full twenty feet, and their structure of single main spar and numerous ribs was easily seen through the nearly transparent fabric that covered them. Within his natural limitations, Barlennan had done an excellent job of description.

"What drives it?" asked one of the watchers suddenly. "There's no propeller or visible jet, and Barlennan said it was silent."

"It's a sailplane." One of the meteorological staff spoke up. "A glider, operated by someone who has all the skill of a Terrestrial sea gull at making use of the updrafts from the front side of a wave. It could easily hold a couple of people Barlennan's size, and could stay aloft until they had to come down for food or sleep—I don't know whether they sleep or not; do they, Charlie?"

"I believe not. This glider, then, might have come from an enormous distance, riding the winds of Mesklin; is that right?"

"It could have; my personal opinion is that it probably is from the islands Barl is approaching."

"Why?"

"They are by far the closest bodies of land. The next nearest, as far as we've seen, is the continental mass that Barlennan's ship left not long ago. If they could fly this far from any other continent, they could reach that one—and we didn't see any; or rather, you didn't. They should, in that case, be swarming all over the equatorial regions."

"Good point, assuming that they are actually of Barlennan's species. I hope we see enough of them to find out. I had pretty well estimated that Barl represented about the top culture of the planet, roughly equal to Earth's tenth century; now we appear to have a race that has learned to fly—under conditions much more difficult than those of Earth, as I understand."

"So it appears, Don. I suppose you'll want us to leave another vision set where you can get a look at their daily lives, too." McKnight smiled and glanced at the other screen, which was showing a scene from the village of the river dwellers.

"I might, at that. What are my chances?"

"Negligible," Lackland said flatly. "I sympathize with you, but basic research comes later. When—and if—we get that gravity data, the bright fellows may rig up something that will let you go down there yourself without having to live in a hydraulic hammock the whole time."

"That would be worth waiting for, I guess. I'll be patient. Of course, our little friend *might* have to buy his way out of a tight spot again." The ethnologist turned back to his own screen and recorder, smiling. Lackland grinned in return.

"I'll call you if he does."

The *Bree's* crew were becoming a trifle nervous. The complete silence of the flying machine, their inability to see who or what was in it now that the Earthmen had explained its nature, bothered them; no one likes to be watched constantly by someone he can't see. The glider made no hostile move, but their experience of aerial assault was still fresh enough to leave them uneasy about its presence. One or two had expressed a desire to practice their newly acquired art of throwing, using any hard objects they could find about the deck, but Barlennan had sternly forbidden this. They simply sailed

on, wondering, until the hazy dome of the sky darkened with another sunset.

Through the night they sailed, wondering; and no one knew whether to be relieved or worried when the new day revealed no trace of the flying machine. The wind was now stronger, and almost directly across the *Bree's* course from the northeast; the waves had not yet followed it and were decidedly choppy in consequence. For the first time Barlennan perceived a disadvantage in the canoe; methane that blew or washed inboard stayed there. He found it necessary before the day was over to haul the little vessel up to the outer rafts and place two men aboard to bail—an act for which he had neither a word nor proper equipment. The sailors were not happy at first, but quickly discovered that relatively little effort was required merely to splash the liquid back overboard. After two or three days Barlennan started to send them out replacements, and was told they were perfectly happy to stay where they were.

The days passed without reappearance of the glider, and eventually only the official lookouts kept their eyes turned upward in expectation of its return. The high haze thickened and darkened, however, and presently turned to clouds which lowered until they hung a scant fifty feet above the sea. Barlennan was informed by the Earthmen that this was not good flying weather, and eliminated the watch. Neither he nor the human beings stopped to wonder how the first glider had found its way on a night too hazy for the stars to provide guidance.

The first of the islands to come into view was fairly high, its ground rising quickly from sea level to disappear into the clouds. It lay downwind from the point where they first sighted it; and Barlennan, after consulting the sketch map of the archipelago he had made from the Earthmen's descriptions, kept on course. As he had expected, another island appeared dead ahead before the first had faded from sight, and he altered course to pass to leeward of it. This side, according to observation from above, was quite irregular and should have usable harbors; also, Barlennan had no intention of coasting the windward shore during the several nights which would undoubtedly be required for his search.

This island appeared to be high also; not only did its hilltops reach the clouds, but the wind was in large measure cut off as the *Bree* passed into its lee. Her speed dropped considerably, but remained high enough to satisfy her commander, particularly as the search ended almost as soon as it began. The shore line was cut by frequent fiords; Barlennan was intending simply to sail across the mouth of each in the hunt, but Dondragmer insisted that it would be worth while to penetrate to a point well away from the open sea. He claimed that almost any beach far enough up would be adequate shelter. Barlennan was convinced only to the point of wanting to show the mate how wrong he was.

Unfortunately for this project, the first fiord examined made a sharp hook-turn half a mile from the ocean and opened into what amounted to a lake, almost perfectly circular and about a hundred yards in diameter. Its walls rose into the mist except at the mouth where the *Bree* had entered and a smaller opening only a few yards from the first where a stream from the interior fed into the lake. The only beach was between the two openings.

The crew discovered these facts bit by bit, for the wind was funneling

down into this circular space and out along the fiord, carrying fragments of cloud nearly down to surface level and blanketing the view almost completely. The small stream was quite wide and deep enough for the ship, but she could not be moved into it against both wind and current; so she was beached there in the lake. Certainly there seemed little chance of destructive waves reaching her there, anyway.

There was plenty of time to secure both vessel and contents, as it happened; the clouds belonged to the second of the two "normal" cyclones the meteorologist had mentioned, rather than to the major storm. Within a few days of the *Bree's* arrival in the harbor the weather cleared once more, though the wind continued high. Barlennan — and through his aid, the human watchers —was able to see that the harbor was actually the bottom of a bowl-shaped valley whose walls were less than a hundred feet in height, and not particularly steep.

It was possible to see far inland through the cleft cut by the small river, provided one climbed a short distance up the walls. In doing this, shortly after the weather cleared, Barlennan made a disconcerting discovery: sea shells, seaweeds, and bones of fairly large sea animals were thickly scattered among the land-type vegetation clothing the hillside. This continued, he discovered upon further investigation, quite uniformly around the valley up to a height fully thirty feet above the present sea level.

Many of the remains were old, decayed almost to nothing, and partly buried; but these might be accounted for by seasonal changes in the ocean level. Others, however, were relatively fresh. The implication was clear— on certain occasions the sea rose far above its present level; and it was possible that the *Bree* was not in as safe a position as her crew believed.

Barlennan, coming from Mesklin's middle latitudes, knew nothing of tides and still less of tropical hurricanes. The storms he had experienced the preceding winter had not been the tight, fiercely whirling cells that developed a little farther from the equator; and those of his home latitudes could not lift the seas very far against the terrific gravity. Here the low-pressure zone in the center of a tight cyclone could and did raise a dome of liquid in its center, corresponding to the two- or three-foot rise of water in the center of an Earthly tropical hurricane but vastly greater. The lower density of methane and the enormously greater differences in atmospheric pressure in Mesklin's storms more than offset the higher gravity in these latitudes; a thirty-foot rise in sea level was not at all unreasonable or unusual.

One factor alone limited Mesklin's storms to the point where sea travel was possible; methane vapor is far denser than hydrogen. On Earth, water vapor is lighter than air, and contributes enormously to the development of a hurricane once it starts; on Mesklin, the methane picked up from the ocean by such a storm tends, in a relatively short time, to put a stop to the rising currents which are responsible for its origin. Also the heat it gives up in condensing to form the storm clouds is only about a quarter as great as would be given by a comparable amount of water—and that heat is the fuel for a hurricane, once the sun has given the initial push.

In spite of all this, a Mesklinite hurricane is no joke. Barlennan, Mesklinite though he was, learned this very suddenly. He was seriously

considering towing the *Bree* as far upstream as time would permit when the decision was taken out of his hands; the water in the lake receded with appalling suddenness, leaving the ship stranded fully twenty yards from its edge. Moments later the wind shifted ninety degrees and increased to a speed that made the sailors cling for dear life to deck cleats, if they happened to be on board, and to the handiest vegetation if they did not.

The captain's shrill hoot ordering those off the ship to return went completely unheard, sheltered as they were in the almost complete circle of the valley walls; but no one needed any order. They picked their way, bush by bush, never holding with less than two sets of pincers, back to where their comrades had already lashed themselves as best they could to the vessel that was threatening every moment to lift into the wind's embrace. Rain—or, more properly, driven spray that had come completely across the island—lashed at them for long minutes; then both it and the wind ceased as though by magic. No one dare release his lashings, but the slowest sailors now made a final dash for the ship. They were none too soon.

The storm cell at sea level was probably three miles or so in diameter; it was traveling at about sixty or seventy miles per hour. The ending of the wind was only temporary; it meant that the center of the cyclone had reached the valley. This was also the low pressure zone; and as it reached the sea at the mouth of the fiord, the flood came. Up the narrowing waterway it rose, gathering speed as it came, and spurted into the valley like the stream from a hose. Around the walls it swirled, picking up the *Bree* on the first circle; higher and higher, as the ship sought the center of the whirlpool—fifteen, then twenty, then twenty-five feet before the wind struck again.

Tough as the wood of the masts was, they had snapped long since. Two crewmen had vanished, their lashing perhaps a little too hastily completed. The new wind seized the ship, bare of masts as she was, and flung her toward the side of the whirlpool; like a chip, both for helplessness and magnitude, she shot along the stream of liquid now pouring up the little river toward the island's interior. Still the wind urged her, now toward the side of the stream; and as the pressure rose once more, the flood receded as rapidly as it had risen—no, not quite; the portion now floating the *Bree* had nowhere to go except back out through the little rivercourse, and that took time.

Had daylight lasted, Barlennan might, even in his ship's present condition, have guided her back along that stream while she still floated; but the sun chose this moment to set, and in the darkness he ran aground. The few seconds delay was enough; the liquid continued to recede, and when the sun returned it looked upon a helpless collection of rafts some twenty yards from a stream that was too narrow and too shallow to float any one of them.

The sea was completely out of sight beyond the hills; the limp form of a twenty-foot long sea monster stranded on the other side of the brook gave a graphic picture of the helplessness of the Gravity Expedition.

XII.

MUCH of what had happened had been seen from Toorey; the radio sets, like most of the less prominent articles about the *Bree*'s deck, had

remained lashed in position. Not much had been distinguishable, of course, while the vessel had been whirling in the brief maelstrom; but her present situation was painfully clear. None of the people in the screen room could find anything helpful to say.

The Mesklinites could say little, either. They were used to ships on dry land, since that happened fairly often during late summer and fall as the seas receded in their own latitudes; but they were not accustomed to having it happen so suddenly, and to have so much high ground between them and the ocean. Barlennan and the mate, taking stock of the situation, found little to be thankful for.

They still had plenty of food, though that in the canoe had vanished. Dondragmer took occasion to point out the superiority of rafts, neglecting to mention that the supplies in the canoe had been tied down carelessly or not at all owing to a misplaced confidence in the high sides of the boat. The little vessel itself was still at the end of its towline, and still undamaged. The wood of which it had been made shared the springiness of the low-growing plants of the higher latitudes. The *Bree* herself, constructed of similar materials though in much less yielding form, was also intact, though the story might have been different had there been many rocks in the wall of the round valley. She was and had remained right side up, owing to her construction—Barlennan admitted that point without waiting for the mate to bring it up. The complaints were not in any way connected with lack of ship or supplies, but with lack of an ocean to float them on.

How to move the ship—or whether to abandon her and build another beside the sea. No one thought of, much less expressed, the alternative of simply settling down where they were.

"The surest way would be to take her apart, as we did before, and carry her over the hills. They're not very steep, and there still isn't enough weight to matter." Barlennan made this suggestion after long thought.

"You're probably right, captain; but wouldn't it save time to separate the rafts only lengthwise, so that we have rows the full length of the ship? We could carry or drag those over to the stream, and surely they'd float before we went down very far." Hars, now his former self after his encounter with the rock, made this suggestion.

"That sounds promising. Hars, why don't you find out just how far down that would be? The rest can start unlashing as Hars suggested, and unloading where we have to. Some of the cargo will be in the way of the lashings, I'm afraid."

"I wonder if the weather is still too bad for those flying machines?" Dondragmer asked, of no one in particular. Barlennan glanced upward.

"The clouds are still low and the wind high," he said. "If the Flyers are right—and they ought to know, I should think—the weather is still too bad. However, it won't hurt to look up occasionally. I rather hope we see one again."

"*One* I wouldn't much mind myself," replied the mate dryly. "I suppose you want a glider to add to the canoe. I'll tell you right now that I might, in extremity, get into the canoe, but the day I climb onto one of those flying machines will be a calm winter morning with both suns in the sky."

Barlennan did not answer; he had not consciously considered adding a glider to his collection, but the idea

rather struck his fancy. As for flying in it—well, changed as he was, there were limits.

The Flyers reported clearing weather, and the clouds obediently thinned over the next few days. Greatly improved though the flying weather was, few crew members thought to watch the sky. All were too busy. Hars' plan had proved feasible, the stream being deep enough for the rafts only a few hundred yards toward the sea and wide enough for a single raft very little further down. Barlennan's statement that the additional weight would mean little proved wrong; every component was twice as heavy as it had been where they last saw Lackland, and they were not accustomed to lifting *anything*.

Powerful as they were, the new gravity taxed their hoisting abilities to the point where it was necessary to unload the rafts before the rows of little platforms could be partly carried and partly dragged to the stream. Once they were partly immersed the going was much simpler; and after a digging squad had widened the banks up to the point nearest the *Bree's* resting place the job became almost easy. Not too many hundred days passed before the long, narrow string of rafts, reloaded, was being towed once more toward the sea.

If gliders had ever been in the neighborhood none of the *Bree's* crew had seen them. The sailors must have been watching from somewhere, however; for the activities of the next people they met were much too well timed to represent anything but foreknowledge and planning.

The flying machines appeared just after the ship had entered that portion of the stream where its walls were steepest, shortly before it emptied into the lake. Karondrasee saw them first; he was on board at the time, preparing food while the others pulled, and his attention was freer than theirs. His hoot of alarm roused Earthmen and Mesklinites alike, but the former as usual could not see the approaching visitors since the vision sets were not aimed high enough.

Barlennan saw all too clearly, however. There were eight of the gliders, traveling fairly close together but by no means in tight formation. They came straight on, riding the updraft on the leeward side of the little valley until they were almost over the ship; then they changed course to pass in front of her. As each swooped overhead, it released an object, turned, and swung back to the lee side to recover its altitude.

The falling objects were distinct enough; every sailor could see that they were spears, very much like those the river dwellers had used but with much heavier tips. For a moment the old terror of falling objects threatened to send the crew into hysteria; then they saw that the missiles would not strike them, but fall some distance in front.

A few seconds later the gliders swooped again, and the sailors cowered in expectation of an improved aim; but the spears fell in about the same place. With the third pass it became evident that their aim was deliberate; and presently their purpose became apparent. Every projectile had fallen in the still narrow stream, and penetrated more than half its length into the firm clay bottom; by the end of the third run, two dozen stakes formed by the spear handles were effectually blocking the ship's passage downstream.

As the *Bree* approached the barricade, the bombardment stopped. Barlennan had thought it might be

continued to prevent their approaching and clearing the obstacle away, but when they reached it they found this to be superfluous. The spears were there to stay; they had been dropped from nearly a hundred feet with superlative aim in a field of seven gravities, and nothing short of power machinery was going to extract them. Terblannen and Hars proved that in five minutes of fruitless upward tugging.

"Can't you cut them?" Lackland asked from his distant observation point. "Those pincers of yours are pretty powerful, as I know."

"These are wood, not metal," Barlennan replied. "We would need one of your hard metal saws, which you claimed would attack even our wood—unless you have some machine for pulling them out."

"You must have tools which will cut it; how do you do repair work on your ship? The rafts certainly didn't grow in that shape."

"Our cutting tools are made of animal teeth set in strong frames, and most of them are not very portable. What we have we will use, but I doubt that we'll be given time to do much."

"I should think you could keep attackers away by fire."

"We can, if they come from downwind. I find it hard to imagine their being that stupid."

Lackland fell silent, while the crew fell to work on the stakes with such edged tools as they could find. Their personal knives were of hardwood and would make no impression on the spears, but as Barlennan had intimated there were a few bone and ivory cutters, and these began to chip away at the incredibly tough wood.

Digging was also attempted by some of the crew who lacked tools; they took turns in sinking to the bottom of the inches-deep brook, working the clay loose and letting its particles wash away in the sluggish current. Dondragmer watched these workers for a time, then pointed out that it would probably be easier to dig a canal around the obstruction than to grub out two dozen sticks from a depth of some four feet. This suggestion was eagerly adopted by the members of the crew who had nothing to cut with, and work progressed at a remarkable rate.

The gliders kept circling while all this was going on; apparently they either remained overnight or were replaced by others during the minutes of darkness—no one could tell which. Barlennan kept a sharp watch on the hills to either side of the stream, expecting ground forces to appear at any moment; but for a long time his own crew and the gliders formed the only moving parts of the scenery.

The crews of the gliders themselves remained invisible; no one could even tell how many or what sort of creatures rode in the machines, though both human beings and Mesklinites had come to take more or less for granted that they belonged to Barlennan's race. They showed no evident anxiety about the sailors' digging activities but it became evident finally that the excavation had not gone unnoticed.

The job was about three quarters finished when they took action; another series of bombing runs left the path of the new waterway as completely staked off as the original. As before, pains were apparently taken to avoid transfixing any of the crew. The action, however, was about as discouraging as if it had been a personal assault; quite evidently the digging process was useless, since the work of days could be nullified in a matter of minutes. Some other line of procedure must be devised.

At the Earthmen's advice Barlennan had long since ordered his men not to gather in large groups; but now he drew them in toward the ship, establishing a loose cordon parallel to the string of rafts on each side of the creek. The men were far enough apart so there was no really tempting target from above, and close enough to support each other in case an attack actually developed. There they stayed; Barlennan wished it made evident that the next move was up to the personnel of the gliders. They failed to make it, however, for several more days.

Then a dozen more of the flimsy craft appeared in the distance, swooped overhead, split into two groups and landed on the hilltops to either side of the imprisoned ship. The landings were made as the Flyers had foretold, into the wind; the machines skidded to a stop in a few feet from their point of touchdown. Four beings emerged from each, leaped to the wings, and hastily tied the gliders down, using the local bushes as anchors. What had been assumed all along now proved to be a fact; they were identical in form, size and coloring with the sailors of the *Bree*.

Once the gliders were secured their crews proceeded to set up a collapsible structure upwind from them, and attach cords equipped with hooks to this. They appeared to be measuring quite carefully the distance from this device to the nearest glider. Only when this task was completed did they pay any attention to the *Bree* or her crew. A single prolonged wail that sounded from one hilltop to the other apparently served as a signal that the work was complete.

Then the glider crews on the leeward hill began to descend the slope. They did not leap, as they had during the action subsequent to landing, but crawled in the caterpillarlike fashion which was the only means of locomotion Barlennan's people had known prior to his exploration of the Rim. In spite of this they made good speed, and were within reasonable throwing distance—as several of the more pessimistic sailors regarded it—by sundown. They stopped at that point and waited for the night to pass; there was just enough light from the moons for each party to see that the other did nothing suspicious.

With the coming of sunlight the advance was resumed, and eventually terminated with one of the newcomers only a yard or so from the nearest sailor, while his companions hung a few feet farther back. None of the party seemed to be armed, and Barlennan went to meet them, first ordering two sailors to swing one of the vision sets so that it pointed directly at the place of meeting.

The glider pilot wasted no time, but began speaking as soon as Barlennan stopped in front of him. The captain failed to understand a word. After a few sentences the speaker appeared to realize this; he paused and, after a moment, continued at somewhat slower speed in what Barlennan judged to be a different language. To save the time that a random search through the tongues known to the other would consume, Barlennan this time indicated his lack of comprehension verbally. The other shifted languages once more, and rather to his surprise Barlennan heard his own speech, uttered slowly and badly pronounced, but quite comprehensible.

"It is long since I have heard your tongue spoken," the other said. "I trust I can still be understood when I use it. Do you follow me?"

"I can understand you perfectly well," replied Barlennan.

"Good. I am Reejaaren, linguist for Marreni, who is Officer of the

Outer Ports. I am ordered to find out who you are and where you are from, and your purpose in sailing the seas about these islands."

"We are on a trading journey, with no particular destination." Barlennan had no intention of talking about his connection with the creatures of another world. "We did not know of the existence of these islands; we simply were heading away from the Rim, of which we had had enough. If you wish to trade with us we are willing to do business; if not, we ask only to be allowed to continue our journey."

"Our ships and gliders trade on these seas—we have never seen others," replied Reejaaren. "I fail to understand one point. The trader far to the south from whom I learned your language said that he came from a country that lay on the farther side of a sea across the western continent. We know that there is no sea passage from that ocean to this between here and the ice; yet you were sailing from the north when we first sighted you. That would suggest that you were quartering back and forth through these seas in deliberate search of land. How does that square with your story? We do not like spies."

"We came from the north after crossing the land between this ocean and ours." Barlennan had no time to think up a convincing lie, though he realized that the truth was likely to be unbelievable. Reejaaren's expression showed that he was right.

"Your ship was obviously built with large tools, which you do not have. That means a shipyard, and there is none to the north on this ocean. Do you want me to believe you took her apart and dragged her across that much land?"

"Yes." Barlennan felt that he saw his way out.

"How?"

"How do you fly? Some would find that much harder to believe." The question was not quite as good a one as Barlennan had hoped, judging by the interpreter's reaction.

"I am sure you do not expect me to tell you that. Mere trespassers we may tolerate; but spies receive much harder treatment." The captain covered up as well as he could.

"I did not expect you to tell me. I was simply pointing out as tactfully as possible that perhaps you should not have asked me how we crossed the land barrier."

"Oh, but I should—and must. You do not yet seem to realize your position, Stranger. What you think of me is unimportant; but what I think of you counts a great deal. To put it simply, to leave here as you desire you will have to convince me that you are harmless."

"But what harm could we do you—the crew of a single ship? Why should you fear us so?"

"We do not fear you!" The answer was sharp and emphatic. "The damage you could do is obvious—one person, let alone a shipload, could take away information which we do not wish to give. We realize, of course, that the barbarians could not learn the secret of flight unless it were very carefully explained to them; that is why I laughed at your question. Still, you should be more careful."

Barlennan had not heard any laughter, and began to suspect a good deal about the interpreter and his people. For some reason they *were* unusually afraid of other races and nations; the contempt expressed by Reejaaren's word "barbarians" was not usual and hardly defensible. Whether he actually regarded Barlennan as his inferior in culture and knowledge was hard to tell; but the captain was practical psychologist enough not to

say or do anything that would tend to oppose such a belief. There was no point in getting the interpreter angry—contempt was a safer emotion, whether the situation came to selling or simply getting away. A half truth that seemed like yielding on Barlennan's part would probably be the best move.

We had much help pulling the ship across the land" he said, putting a little sullenness in his tone.

"From the rock-rollers and river-dwellers? You must have a remarkably persuasive tongue. We have never received anything but missiles from them."

To Barlennan's relief, Reejaaren did not pursue the subject further. He returned to more immediate matters.

"So you desire to trade with us, now that you are here. What have you to trade? And I suppose you wish to go to one of our cities?" Barlennan sensed the trap, and answered accordingly.

"We will trade here, or anywhere else you desire, though we would rather not go any farther from the sea. All we have to trade at the moment is a load of foods from the isthmus, which you doubtless have in great quantity already because of your flying machines."

"Food can usually be sold," the interpreter replied noncommittally. "Would you be willing to do your trading before you got any closer to the sea?"

"If necessary, as I said, though I don't see why it should be necessary. Your flying machines could catch us before we got very far, if we tried to leave the coast before you wanted, couldn't they?" Reejaaren might have been losing his suspicions up to this point, but the last question restored them in full force.

"Perhaps we could, but that is not for me to say. Marreni will decide, of course, but I suspect you might as well plan on lightening your ship here. There will be port fees, of course, in any case."

"Port fees? This is no port, and I didn't land here; I was washed up."

"Nevertheless, foreign ships must pay port fees. I might point out that the amount is determined by the Officer of the Outer Ports, and he will get much of his impression of you through me. A little more courtesy might be in order."

Barlennan restrained his temper with difficulty, but agreed aloud that the interpreter spoke the clearest truth. He said it at some length, and apparently mollified that individual to some extent. At any rate he departed without further threats, overt or implied. Barlennan expressed himself to his mate at length and with feeling as the interpreter climbed the hill once more and got into his glider.

Two of his fellows accompanied him; the other remained behind. Men from the other gliders hastily seized the two ropes attached to the collapsible framework and pulled. The cords stretched unbelievably, until their hooks were finally fastened to an attachment in the glider's nose. The aircraft was then released and the ropes contracted to their original length, hurling the glider into the air. Barlennan instantly formed a heartfelt desire for some of that stretching rope. He said so, and Dondragmer sympathized. He had heard the entire conversation, and sympathized also with his captain's feelings toward the linguist for the Officer of the Outer Ports.

"You know, Barl, I think we could put that lad in his place. Want to try it?"

"I'd love to, but I don't think we can afford to let him get mad at us until we're good and far away. I don't want him and his friends dropping their spears on the *Bree* now or any other time."

"I don't mean to make him angry, but afraid of us. 'Barbarians'—he'll eat that word if I have to cook it personally for him. It all depends on certain things: do the Flyers know how these gliders work, and will they tell us?"

"They probably know, unless they've had better ones for so long they've forgotten—"

"So much the better, for what I have in mind."

". . . But I'm not sure whether they'll tell. I think you know by now what I'm really hoping to get out of this trip; I want to learn everything I possibly can of the Flyers' science. That's why I want to get to that rocket of theirs near the Center; Charles himself said that it contained much of the most advanced scientific equipment they have. When we have that, there won't be a pirate afloat or ashore who'll be able to touch the *Bree*, and we'll have paid our last port dues—we'll be able to write our own menus from then on."

"I guessed as much."

"That's why I wonder whether they'll tell what you want; they may suspect what I'm after."

"I think you're too suspicious yourself. Have you ever *asked* for any of this scientific information you want to steal?"

"Yes; Charles always said it was too difficult to explain."

"Maybe he was right; maybe he doesn't know it himself. I want to ask one of his people about these gliders, anyway; I want to watch that Reejaaren grovel."

"Just what is this idea of yours, anyway?"

Dondragmer told him, at length. The captain was dubious at first, but gradually grew more enthusiastic; and finally they went over to the radios together.

XIII.

FORTUNATELY, Reejaaren did not return for a good many days. His people remained; four to six gliders were always drifting overhead, and several more squatted on the hilltops beside their catapults. The number of aircraft did not change noticeably, but the population of the hilltops increased day by day. Barlennan could not tell whether gliders were leaving and returning with more people, or whether some or all of the newcomers were arriving on foot. He did not particularly care, since he had matters of more immediate importance to settle. No further attempt was being made to free the ship, since that would obviously be an error in diplomacy; but the crew was busy just the same.

Barlennan and his mate were alternately at the radios and talking long and earnestly to the crew; the Earthmen above had entered into Dondragmer's plan with enthusiasm and, Barlennan suspected, some little amusement. A few of the sailors were unable to pick up what was needed with sufficient speed, and had to be left out of the main plan in one sense; but even they understood the situation and would, Barlennan was sure, be able to contribute to the desired effect. In the meantime, he put them to work repairing the shattered masts, whose rigging had at least kept them with the ship.

Some other physical work was also done during this time; such goods as Barlennan cared to trade from the material he had acquired crossing the isthmus were unloaded and displayed on shore. As he had said, they amounted to little, principally supplies of the "fir cones" and materials acquired from the rock-rollers. The captain did not care too much whether these were

greatly desired by his present customers or not, provided he could unload enough to purchase some of the stretching rope and a supply of the fabric used in covering the wings on the gliders. The latter was a new desire, picked up as a result of his conversations with the Earthmen about the operation of the flying machines.

He realized perfectly well that neither item might be for sale, but he intended to try, anyway. He saw uses for both of them.

The plan was matured and well rehearsed long before the interpreter's return, and the officers found themselves impatient to try it out though Dondragmer had been spending time at the radio meanwhile on yet another project. In fact, after controlling themselves for a few days, the captain and mate strolled one morning up the hill toward the parked gliders with a full determination to make a test of the idea, though neither had said a word to the other about his intention. The weather had completely cleared long since, and there was only the perpetual wind of Mesklin's seas to help or hinder flying. Apparently it wanted to help; the gliders were tugging at their tie-down cables like living creatures, and crewmen were standing by the wings with a secure grip on the surrounding bushes, evidently ready to add their strength if necessary to that of the restraining lines.

Barlennan and Dondragmer approached the machines until they were ordered sharply to halt. They had no idea of the rank or authority of the individual giving the order, since he wore no insignia; but it was not part of their plan to argue such matters. They halted, and looked over the machines casually from a distance of thirty or forty yards, while the crewmen looked back rather belligerently. Apparently Reejaaren's superciliousness was not a rare trait with his nation.

"You look astonished, Barbarians," one of them remarked after a brief silence. "If I thought you could learn anything by looking at our machines, I would have to force you to stop. As it is, I can only assure you that you look rather childish." He spoke Barlennan's tongue with an accent not much worse than that of the chief linguist. Dondragmer found time to wonder how his own language came to be known even this well in a country which had managed to keep its very existence secret from his people. Barlennan did not wonder; he seized the opportunity.

"There seems little to learn from your machines. You could save much trouble with the wind in your present situation by warping the front of your wings down; why do you keep so many people busy instead?" He used the English word for "wings," not having one in his own language. The other requested an explanation; receiving it, he was startled out of his superiority for a moment.

"You have seen gliders before? Where?"

"I have never seen *your* type of flying machine in my life," Barlennan answered. His words were truthful, though their emphasis was decidedly misleading. "I have not been this close to the Rim before, and I should imagine that these flimsy structures would collapse from their added weight if you flew them much farther south."

"How—?" the guard stopped, realizing his attitude was not that of a civilized being toward a barbarian. He was silent for a moment, trying to decide just what his attitude should be in this case; then he decided to pass the problem higher in the chain of command. "When Reejaaren returns, he will no doubt be interested in any minor improvements you may be able

to suggest. He might even reduce your port fee, if he deems them of sufficient value. Until then, I think you had better stay entirely away from our gliders; you might notice some of their more valuable features, and then we would regretfully have to consider you a spy."

Barlennan and his mate retired to the *Bree* without argument, highly satisfied with the effect they had produced, and reported the conversation in its entirety to the Earthmen.

"You say that more than one of them speaks your language, and yet none of your people have ever heard of this country?" asked Lackland when the captain had finished. "They seem to have explorers of their own, then, and ships as well. Their reasons for keeping their own country unknown might be very interesting to your government."

"I can believe that," replied Barlennan, to whom Dondragmer had already communicated his thoughts on this subject. "They wouldn't need ships, though; perhaps they fly to the continent at this or lower latitudes, and then travel overland to better known parts of the world. Many of our trading caravans have penetrated to the eastern shore of the continent, though of course far south of here."

"That may be true. If so, you'll have to hope that the explorers from these islands did not learn too much about your country along with the language."

"I wouldn't worry about that," put in Dondragmer. "They'll probably assume that we kept our knowledge secret just as they have theirs."

"How do you think he reacted to the implication that you had gliders capable of flying up in the two-hundred-gravity latitudes?" asked Lackland. "Do you think he believed you?"

"I couldn't say; he decided about then either that he was saying too much or hearing too much, and put us in storage until his chief returns. I think we started the right attitude developing, though."

Barlennan may have been right, but the interpreter gave no particular evidence of it when he returned. There was some delay between his actual landing and his descent of the hill to the *Bree*, and it seemed likely that the guard had reported the conversation; but he made no reference to it at first. He was accompanied by quite a large party this time, and many more people who must have come by some mode of ground travel began to gather on the hills looking down on the imprisoned vessel. Reejaaren's attitude was still one of superiority.

"The Officer of the Outer Ports has decided to assume for the moment that your intentions are harmless," he began. "You have, of course, violated our rules in coming ashore without permission; but he recognized that you were in difficulties at the time, and is inclined to be lenient. He authorizes me to inspect your cargo and evaluate the amount of the necessary port fee and fine."

"The officer would not care to see our cargo for himself and perhaps accept some token of our gratitude for his kindness?" Barlennan managed to keep sarcasm out of his voice. Reejaaren gave the equivalent of a smile.

"Your attitude is commendable, and I am sure we will get along very well with each other. Unfortunately, he is occupied on one of the other islands, and will be for many days to come. Should you still be here at the end of that time, I am sure he will be delighted to take advantage of your offer. In the meantime we might proceed to business."

Reejaaren lost little if any of his superiority during his examination of the *Bree's* cargo, but he managed to

give Barlennan some information during the process which he would probably have died rather than give consciously. His words, of course, tended to belittle the value of everything he saw; he harped endlessly on the "mercy" of his so-far-unseen chief, Marreni. However, he appropriated as fine a respectable number of the "fir-cones" that had been acquired during the journey across the isthmus.

Now, these should have been fairly easy to obtain here, since the distance could not be too great for the gliders—in fact, the interpreter had made remarks indicating acquaintance with the natives of those regions. If, then, Reejaaren held the fruit as being of value, it meant that the "barbarians" of the isthmus were a little too much for the interpreter's highly cultured people, and the latter were not so close to being the lords of creation as they wanted people to think.

Barlennan remembered in this connection that when Marreni's assistant first heard about the fruit he had hastily credited the captain with diplomacy rather than military prowess. Reejaaren would probably not want to admit even to himself that anyone surpassed his people in the latter quality. He was, in short, conscious of weakness; Barlennan's excellent knowledge of practical psychology let him picture the situation with some accuracy, though he had no term in his language equivalent to "inferiority complex." That suggested that the mate's plan had a very good chance of success, since the interpreter would probably do almost anything rather than appear inferior to the "barbarian" crew of the *Bree*.

Barlennan, reflecting on this, felt his morale rise like the Earthmen's rocket; he was going to be able to lead this Reejaaren around like a pet *ternee*. He bent all his considerable skill to the task, and the crew seconded nobly.

Once the fine was paid, the spectators on the hills descended in swarms; and the conclusion about the value of the fir-conelike fruit was amply confirmed. Barlennan at first had a slight reluctance to sell all of it, since he had hoped to get really high prices at home; but then he reflected that he would have to go back through the source of supply before reaching his home in any case.

Many of the buyers were evidently professional merchants themselves, and had plentiful supplies of trade goods with them. Some of these were also edibles, but on their captain's orders the crew paid these little attention. This was accepted as natural enough by the merchants; after all, such goods would be of little value to an overseas trader, who could supply his own food from the ocean but could hardly expect to preserve most types of comestibles for a long enough time to sell at home. The "spices" which kept more or less permanently were the principal exception to this rule, and none of these were offered by the local tradesmen.

Some of the merchants, however, did have interesting materials. Both the cord and the fabric in which Barlennan had been interested were offered, rather to his surprise. He personally dealt with one of the salesmen who had a supply of the latter. The captain felt its unbelievably sheer and even more incredibly tough texture for a long time before satisfying himself that it was really the same material as that used in the glider wings. Reejaaren was close beside him, which made a little care necessary.

He learned from the merchant that it was a woven fabric in spite of appearances, the fiber being of vegetable origin—the canny salesman refused to be more specific—the cloth being treated after weaving with a

liquid which partly dissolved the threads and filled the holes with the material thus obtained.

"Then the cloth is windproof? I think I could sell this easily at home. It is hardly strong enough for practical uses like roofing, but it is certainly ornamental, particularly the colored versions. I will admit, though it is hardly good buying procedure, that this is the most salable material I have yet seen on this island."

"Not strong enough?" It was Reejaaren rather than the merchant who expressed indignation. "This material is made nowhere else, and is the only substance at once strong and light enough to form the wings of our gliders. If you buy it, we will have to give it to you in bolts too small for such a purpose—no one but a fool, of course, would trust a sewn seam in a wing."

"Of course," Barlennan agreed easily. "I suppose such stuff could be used in wings here, where the weight is so small. I assure you that it would be quite useless for the purpose in high latitudes; a wing large enough to lift anyone would tear to pieces at once in any wind strong enough to furnish the lift."

This was almost a direct quote from one of his human friends, who had been suggesting why the gliders had never been seen in countries farther south. He was quite sure he would not actually have to tell any lies; it would be more than surprising if Reejaaren were to ask him any questions about how gliders were built in the high latitudes. The official would undoubtedly try to pump him as subtly as possible on the subject; but admit that his own people did not have such machines? Never! His words confirmed this belief.

"Of course, there is very little load on a glider in these latitudes," he agreed. "Naturally, there is no point in building them stronger than necessary here; it adds to the weight." Barlennan decided that his tactical adversary was not too bright.

"Naturally," he agreed. "I suppose with the storms you have here your surface ships must be stronger. Do they ever get flung inland the way mine was? I never saw the sea rise in that fashion before."

"We naturally take precautions when a storm is coming. The rising of the sea occurs only in these latitudes of little weight, as far as I have been able to observe. Actually, our ships are very much like yours, though we have different armament, I notice. Yours is unfamilar to me—doubtless our philosophers of war found it inadequate for the storms of these latitudes. Did it suffer seriously in the hurricane that brought you here?"

"Rather badly," Barlennan lied. "How are your own ships armed?"

He did not for a second expect the interpreter to answer the question in any way, except perhaps a resumption of his former haughtiness, but Reejaaren for once was both affable and co-operative. (He can afford to be, Barlennan thought, after what he's taken off us.) He hooted a signal up the hill to some of his party who had remained above, and one of these obediently came down to the scene of bargaining with a peculiar object in his pincers.

Barlennan had never seen a crossbow, of course, or any other missile weapon. He was suitably impressed when Reejaaren sent three quartz-tipped bolts in a row thudding for over half their six-inch length into the hard trunk of a plant some forty yards away. He also lost most of his surprise at the interpreter's helpfulness; such a weapon would be so much dead weight before the *Bree* was a quarter of the way to her home latitudes. If these people had any

useful weapons at all when they ventured to the south, certainly Reejaaren was not showing them off.

The captain would have liked Dondragmer's opinion, but the mate was aboard the *Bree* busy on his other project. More as a test than anything else, Barlennan offered to buy one of the crossbows; the interpreter pressed it on him as a gift, together with a bundle of bolts. That was good enough for the captain; as a trader, he naturally enjoyed being taken for a fool. It was usually profitable.

He secured an incredible quantity of the wing fabric—which Reejaaren either forgot to make sure was in small bolts, or no longer considered it necessary—much of the elastic rope, and enough of the local artifacts to fill the *Bree*'s decks, except for the normal requirements of working space and the area devoted to a reasonable food reserve. There were occasional areas even on Mesklin's seas where animals of edible size might not come within reach of a net, and fishing was difficult during storms.

He was rid of everything sellable that he had brought to the island, with the possible exception of the flame-throwers. Reejaaren had not mentioned these since he had been told they were damaged, though he had obviously recognized them as armament of some sort. Barlennan actually thought of giving him one, minus chlorine ammunition, but realized he would have to explain its operation and even demonstrate. This he had no intention of doing; if these people were not familiar with the weapons he did not want them to know the truth of their nature, and if they were he did not want to be caught in a lie. It was much nicer to have Reejaaren in a good humor.

With the selling completed the crowd of local people gradually melted away; and at last there remained only the gliders and their crews, some of the latter down near the ship and others on the hilltops by their machines. Barlennan found the interpreter among the former group, as usual; he had spent much time talking casually to the sailors. They had reported that he was, as expected, pumping them gently about the flying ability of their people. They had filled their part of the game with noncommittal replies that nevertheless "accidentally" revealed a considerable knowledge of aerodynamics. Naturally, they carefully gave no hint as to how recently the knowledge had been acquired—or its source.

Even those who had not been able to digest the information furnished by the earthmen completely enough to obtain a coherent mental picture of the gliders' operation had managed to inject into their replies a suggestion of familiarity with flying machines—they were all merchants, and therefore actors, and they had been subjected to a concentrated dose of flying atmosphere while their fellows were being indoctrinated. Barlennan at this point was reasonably sure that the islanders, or at least their official representative, believed his people capable of flight.

"That seems to be all I can give or take," he said, as he secured Reejaaren's attention. "We have, I think, paid all the necessary fees. Is there any objection to our departing?"

"Where do you plan to go now?"

"Southward, toward decent weight. We do not know this ocean at all, except by vague reports from some of our merchants who have made the overland journey. I should like to see more of it."

"Very well. You are free to go. Doubtless you will see some of us on your travels—I occasionally go south myself. Watch out for more storms."

The interpreter, apparently the picture of cordiality, turned up the hill. "We may see you at the coast," he added, looking back. "The fiord where you first landed has been suggested as possibly improvable to harbor status, and I want to inspect it. He resumed his journey to the waiting gliders.

Barlennan turned back to the ship, and was about to give orders for immediate resumption of the downstream journey—the goods had been loaded as fast as they were purchased —when he realized that the stakes dropped by the gliders still barred the way. For an instant he thought of calling the islander back and requesting their removal; then he thought better of it. He was in no position to make a demand, and Reejaaren would undoubtedly grow supercilious again if he put it as a request. The *Bree's* crew would dig out of their own troubles.

On board, he issued an order to this effect, and the cutters were once more picked up; but Dondragmer interrupted.

"I'm glad to see that this work wasn't wasted time," he said.

"What?" asked the captain. "I knew you were at some stunt of your own for the last forty or fifty days, but was too busy to find out what it was. We were able to handle the trading without you. What have you been doing?"

"It was an idea that struck me just after we were first caught here; something you said to the Flyers about a machine to pull out the stakes gave it to me. I asked them later if there was such a machine that was *not* too complicated for us to understand, and after some thinking one of them said there was. He told me how to make it, and that's what I've been doing. If we rig a tripod by one of the stakes, I'll see how it works."

"But what is the machine? I thought all the Flyer's machines were made of metal, which we couldn't fashion because the kinds that are hard enough need too much heat."

"This." The mate displayed two objects on which he had been working. One was simply a pulley of the most elementary design, quite broad, with a hook attached. The other was rather similar but double, with peg-like teeth projecting from the circumference of both wheels. The wheels themselves were carved from a solid block of hardwood, and turned together. Like the first pulley, this was equipped with a hook; in addition there was a strap of leather threaded through the guards of both wheels, with holes punched in it to match the peg teeth, and the ends buckled together so that it formed a continuous double loop. The whole arrangement seemed pointless to the Mesklinites—including Dondragmer, who did not yet understand why the device worked, or even whether it actually would. He took it over in front of one of the radios and spread it out on the deck.

"Is this now assembled correctly?" he asked.

"Yes, it should work if your strap is strong enough," came the answer. "You must attach the hook of the single pulley to the stake you want to extract; I am sure you have methods of doing that with rope. The other pulley must be fastened to the top of the tripod. I've told you what to do from then on."

"Yes, I know. It occurred to me that instead of taking much time to reverse the machine after it was wound up tightly, however, I could unfasten the buckle and rethread it."

"That would work, provided you were not lifting a load that had to be supported in the meantime," replied the Earthman. "Good for you, Don."

The crew immediately headed for

the original group of stakes, but Barlennan called to them to wait.

"There aren't so many blocking the canal we were digging. Don, did the Flyer say how long it would take to pull them out with that contraption?"

"He wasn't sure, since he didn't know how deeply they were buried or how fast we could operate it; but he guessed at a day or so each—faster than we could cut through them."

"But not so fast that we wouldn't gain time by having some of us finish that canal while you take as many men as you need to pull the stakes in it. Incidentally, did he have any name for the thing?"

"He called it a differential hoist. The second word is plain enough, but I don't see how to translate the first—it's just a noise to me."

"Me, too. Differential it is. Let's get to work; your watch to the hoist, and mine to the canal." The crew buckled down with a will.

The canal was finished first, since it quickly became evident that most of the crew would be free to dig; two sailors, taking turns on the hoist at intervals of a few minutes, proved enough to start the spear shafts sliding very slowly out of the hard ground. To Barlennan's satisfaction the heads came with them, so that he had eight very effective looking spears when the operation was completed. His people did little work in stone, and the quartz heads were extremely valuable in his estimation.

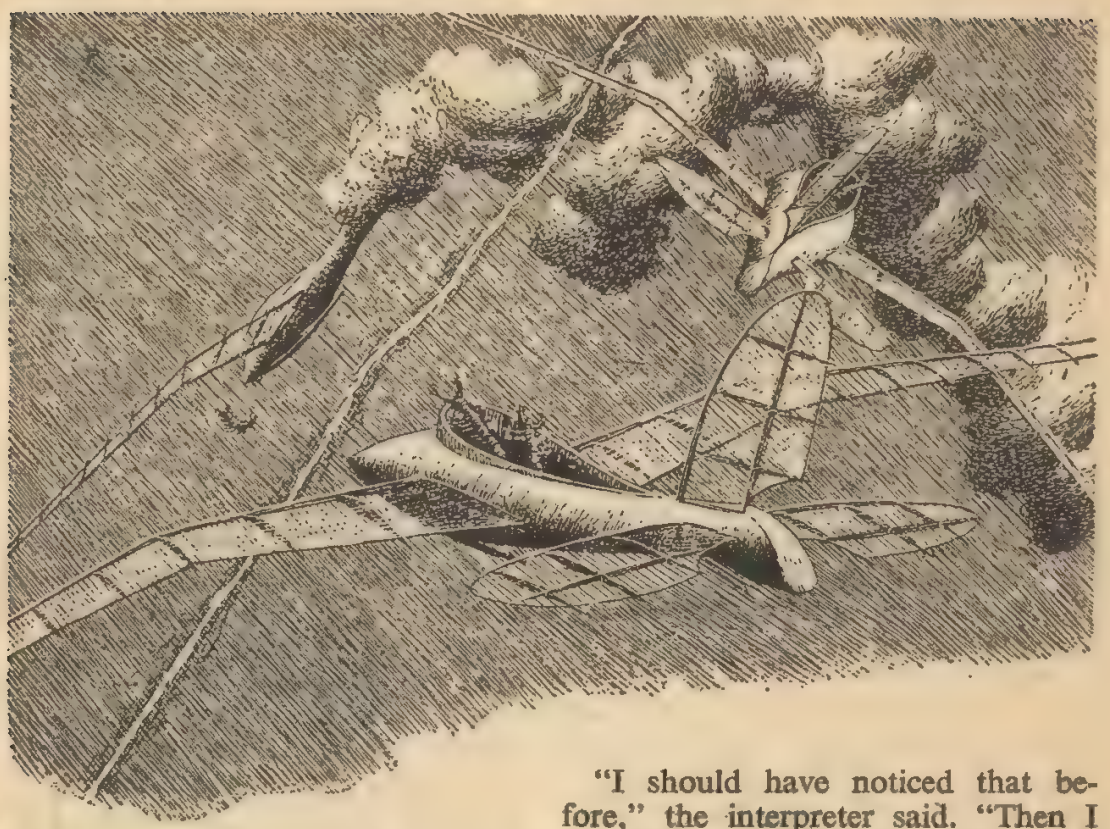
Once through the barrier, the distance to the lake was relatively short; and there they stopped to reassemble the *Bree* in her natural form. This was quickly accomplished—indeed, the crew might now be considered expert at the task—and once more the ship floated in relatively deep water. The Earthmen above heaved a collective sigh of relief. This proved to be premature.

The gliders had been passing back and forth throughout the journey from the trading site. If their crews had been at all surprised at the method used to extract the spears, no evidence had appeared of the fact. Barlennan, of course, hoped they had seen and added the information to the list of his own people's superior accomplishments. He was not too surprised to see a dozen gliders on the beach near the mouth of the fiord, and ordered the helmsman to turn the ship ashore at that point. Perhaps at least the islanders would notice that he had recovered the spears intact.

Reejaaren was the first to greet them as the *Bree* anchored a few yards offshore. "So your ship is seaworthy again, eh? I'd try to meet any more storms a long way from land, if I were you."

"Right," Barlennan agreed. "The difficulty in a sea you don't know is being sure where you stand in that respect. Perhaps you would tell us the disposition of lands in this sea? Or would you, perhaps, have charts you could provide us with? I should have thought to ask before."

"Our charts of these islands, of course, are secret," the interpreter replied. "You should be out of the group in forty or fifty days, however, and then there is no land for some thousands of days' sail to the south. I do not know your ship's speed, so I cannot guess just when you are likely to make it. Such lands as there are are mostly islands at first; then the coast of the land you crossed turns east, and if you keep straight south you will encounter it at about—" he gave an expression which referred to a spring balance reading, and corresponded to about forty-five Earth gravities of latitude. "I could tell you about many of the countries along



that coast, but it would take a long time. I can sum it up by saying that they will probably trade rather than fight—though some will undoubtedly do their best not to pay for what they get."

"Will any of them assume we are spies?" Barlennan asked pleasantly.

"There is that risk, naturally, though few have secrets worth stealing. Actually they will probably try to steal yours, if they know you have any. I should not advise your discussing the matter of flying while there."

"We did not plan to," Barlennan assured him, with glee that he managed to conceal. "We thank you for the advice and information." He gave the order to hoist the anchor, and for the first time Reejaaren noticed the canoe, now trailing once more at the end of its towrope and loaded with food.

"I should have noticed that before," the interpreter said. "Then I would never have doubted your story of coming from the south. How did you get that from the natives?" In the answer to this question Barlennan made his first serious mistake in dealing with the islander.

"Oh, we brought that with us; we frequently use them for carrying extra supplies. You will notice that its shape makes it easy to tow." He had picked up his elementary notions of streamlining from Lackland not too long after acquiring the canoe.

"Oh, you developed that craft in your country, too?" the interpreter asked curiously. "That is interesting; I have never seen one in the south. May I examine it, or do you not have time? We have never bothered to use them ourselves."

Barlennan hesitated, suspecting this last statement to be a maneuver of the precise sort he himself had been employing; but he saw no harm in complying, since Reejaaren could

learn nothing more from a close examination than he could from where he was. After all, it was the canoe's shape that was important, and anyone could see that. He allowed the *Bree* to drift closer inshore, pulled the canoe to him with the towrope, and gave it a push toward the waiting islander.

Reejaaren plunged into the bay and swam out to the little vessel when it ran aground, in a few inches of liquid. The front part of his body arched upward to look into the canoe; powerful pincer-tipped arms poked at the sides. There were of ordinary wood, and yielded springily to the pressure; and as they did so the islander gave a hoot of alarm that brought the four gliders in the air swinging toward the *Bree* and the shore forces up to full alertness.

"Spies!" he shrieked. "Bring your ship aground at once, Barlennan—if that is your real name. You are a good liar, but you have lied yourself into prison this time!"

XIV.

BARLENNAN had been told at various times during his formative years that he was some day pretty sure to talk himself into more trouble than he could talk himself out of. At various later times during his career this prediction had come alarmingly close to fulfillment, and each time he had resolved to be more careful in future with his tongue. He felt the same way now, together with an injured feeling arising from the fact that he did not yet know just what he had said that had betrayed his mendacity to the islander. He did not have time to theorize over it, either; something in the line of action was called for, the quicker the better.

Reejaaren had already howled orders to the glider crews to pin the *Bree* to the bottom if she made a move toward the open sea, and the catapults on shore were launching more of the machines to reinforce those already aloft. The wind was coming from the sea at a sufficient angle to be lifted as it struck the far wall of the fiord so the fliers could remain aloft as long as necessary. Barlennan had learned from the Earthmen that they probably could not climb very high—high enough for effective missile dropping—under the thrust of the updrafts from ocean waves; but he was a long way from the open sea where they would have to depend on such currents. He had already had a chance to observe their accuracy, and dismissed at once any idea of trusting to his dodging ability to save his ship.

As so frequently happened, the action was performed by a crew member while he was debating the best course. Dondragmer snatched up the crossbow that had been given them by Reejaaren, nocked a bolt, and cocked the weapon with a speed that showed he could not have been completely absorbed in his hoist project at all times. Swinging the weapon shoreward he rested it on its single support leg and covered the interpreter with the point.

"Hold on, Reejaaren; you're moving in the wrong direction." The islander stopped on his way out of the bay, liquid dripping from his long body, and doubled his front half back toward the ship to see what the mate meant. He saw clearly enough, but seemed for a moment undecided about the proper course of action.

"If you want to assume I'll probably miss because I've never handled one of those things, go right ahead. I'd like to find out myself. If you don't start coming this way in an awfully short time, though, it will be just as though you had tried to escape. Move!"

The last word was issued in a barking roar that removed much of the interpreter's indecision. He apparently was not quite sure of the mate's incompetence; he continued the doubling movement, re-entered the bay, and swam out to the *Bree*. If he thought of concealing himself by submerging during the process, he evidently lacked the courage to try it. As he well knew, the methane was only a few inches deep even at the ship's location, and would hardly protect him from a bolt hurled with force enough to penetrate three inches of wood after a forty-yard trajectory under seven gravities. He did not think of it in those terms, of course, but he knew very well what those projectiles could do.

He clambered aboard, shaking with rage and fear.

"Do you think this will save you?" he asked. "You have simply made things worse for yourselves. The gliders will drop in any event if you try to move, whether I am aboard or not."

"You will order them not to."

"They will obey no order I give while I am obviously in your power; you should know that if you have any sort of fighting force."

"I've never had much to do with soldiers," Barlennan replied. He had recovered the initiative, as he usually did once things had started in a definite direction. "However, I'll believe you for the time being. We'll just have to hold you here until some understanding is reached concerning this nonsense about our going ashore—unless we can take care of those gliders of yours in the meantime. It's a pity we didn't bring some more modern armament into this backward area."

"You can stop that nonsense now," returned the captive. "You have nothing more than the rest of the savages of the south. I'll admit you fooled us for a time, but you betrayed yourself a moment ago."

"And what did I say that made you think I'd been lying?"

"I see no reason to tell you. The fact that you don't yet know just proves my point. It would have been better for you if you hadn't fooled us so completely; then we'd have been more careful with secret information, and you wouldn't have learned enough to make your disposal necessary."

"And if you hadn't made that last remark, you might have talked us into surrendering," cut in Dondragmer, "though I admit it's not likely. Captain, I'll bet that what you slipped up on was what I've been telling you all along. It's too late to do anything about that now, though. The question is how to get rid of these pesky gliders; I don't see any surface craft to worry about, and the folks on shore have only the crossbows from the gliders that were on the ground. I imagine they'll leave things to the aircraft for the time being." He shifted to English. "Do you remember anything we heard from the Flyers that would help us get rid of these pesky machines?" Barlennan mentioned their probable altitude limitations over open sea, but neither could see how that helped at the moment.

"We might use the crossbow on them." Barlennan made the suggestion in his own language, and Reejaaren sneered openly. Krendoranic, the munitions officer of the *Bree*, who like the rest of the crew had been listening eagerly, was less contemptuous.

"Let's do that," he cut in sharply. "There's been something I've wanted to try ever since we were at that river village."

"What?"

"I don't think you'd want me to talk about it with our friend listening. We'll show him instead, if you are

willing." Barlennan hesitated a moment, then gave consent.

The guard of the islander was taken over by a pair of knife-equipped sailors, and the crossbow given to the munitions officer. He bore it away to his store lockers with an expression that wiped the superiority from the prisoner's face as he saw it.

Barlennan looked a trifle worried as Krendoranic opened one of the flame lockers, but the officer knew what he was doing. He removed a small bundle already wrapped in light-proof material, thus giving evidence of at least some of his occupation during the nights since they had left the village of the river-dwellers.

The bundle was roughly spherical, and evidently designed to be thrown by arm-power; like everyone else, Krendoranic had been greatly impressed by the possibilities of this new art of throwing. Now he was extending his idea even farther, however.

He took the bundle and lashed it firmly to one of the crossbow bolts, wrapping a layer of fabric around bundle and shaft and tying it at either end as securely as possible. Then he placed the bolt in the weapon. He was not able to draw it fully because of the bulge on the shaft, but that did not bother him; the difficulty he had in cocking convinced him that there would still be plenty of kick. He had, as a matter of duty, familiarized himself with the weapon during the brief trip downstream and the reassembly of the *Bree*, and had no doubt about his ability to hit a sitting target at a reasonable distance; he was somewhat less sure about moving objects, but at least the gliders could only turn rapidly if they banked sharply, and that would give him warning.

At his order, one of the sailors who formed part of his flame-thrower crew moved up beside him with the igniting device, and waited. Then, to the intense annoyance of the watching Earthmen, who had been prevented by their inability to understand Barlennan's language from fully grasping what was occurring anyway, he crawled to the nearest of the radios and set the leg of the bow on top of it to steady himself and the weapon in an upward position. This effectively prevented the human beings from seeing what went on, since the radios were set to look outward from a central point and neither of the others commanded a view of the first.

As it happened, the gliders were still making relatively low passes, some fifty feet above the bay, and coming directly over the *Bree* on what could on an instant's notice become bomb runs; so a much less experienced marksman than the munitions officer could hardly have missed. He barked a command to his assistant as one of the machines approached, and began to load it carefully. The moment he was sure of his aim, he gave a command of execution and the assistant touched the igniter to the bundle on the slowly rising arrow point. As it caught, Krendoranic's pincers tightened on the trigger and a line of smoke marked the trail of the missile from the bow.

Krendoranic and his assistant ducked wildly back to deck level and rolled upwind to get away from the smoke released at the start; sailors to leeward of the release point leaped to either side. By the time they felt safe, the air action was almost over.

The bolt had come as close as possible to missing entirely; the marksman had underestimated his target's speed. It had struck about as far aft on the main fuselage as it could, and the bundle of chlorine powder was blazing furiously. The cloud of flame was spreading to the rear of the glider and leaving a trail of smoke that the

following machines made no effort to avoid. The crew of the target ship escaped the effects of the vapor, but in a matter of seconds their tail controls burned away. The glider's nose dropped and it fluttered down to the beach, pilot and crew leaping free just before it touched. The two aircraft which had flown into the smoke also went out of control as the hydrogen chloride fumes incapacitated their personnel, and both settled into the bay. All in all, it was one of the great anti-aircraft shots of history.

Barlennan did not wait for the last of the victims to crash, but ordered the sails set. The wind was very much against him, but there was depth enough for the centerboards, and he began to tack out of the fiord. For a moment it looked as though the shore personnel were about to turn their own crossbows on the ship, but Krendoranic had loaded another of his frightful missiles and aimed it toward the beach, and the mere threat sent them scampering for safety—upwind; they were sensible beings for the most part.

Reejaaren had watched in silence while his bodily attitude betrayed blank dismay. Gliders were still in the air and some were climbing as though they might attempt runs from a higher altitude; but he knew perfectly well that the *Bree* was relatively safe from any such attempt, excellent though his aimers were. She was riding a choppy sea as the wind bucked the current from up the fiord, and her speed and course were both far too variable to make a satisfactory target. One of the gliders did make a run at about three hundred feet, but another trail of smoke whizzing past spoiled his aim badly and no further attempts were made. The machines drifted in wide circles well out of range while the *Bree* slipped on down the fiord to the sea.

"What has been happening Barl?" Lackland, unable to restrain himself longer, decided it was safe to speak as the crowd on shore dwindled with distance. "I haven't been butting in for fear the radios might spoil some of your plans, but please let us know what you've been doing."

Barlennan gave a brief resumé of the events of the last few hundred days, filling in for the most part the conversations his watchers had been unable to follow. The account lasted through the minutes of darkness and sunrise found the ship almost at the mouth of the fiord. The interpreter had listened with shocked dismay to the conversation between captain and radio; he assumed, with much justice, that the former was reporting the results of his spying to his superiors, though he could not imagine how it was being done. Apparently the nation this shipmaster represented had abilities that transcended anything he had ever imagined; and as Barlennan had suspected, the realization actually forced upon him collapsed his morale completely.

With the coming of sunrise he asked to be put ashore in a tone completely different from any he had used before; and Barlennan, taking pity on a creature who had probably never asked for a favor in his life from a member of another nation, let him go overboard from the moving vessel fifty yards from the beach. He did not dare come to a stop or take the ship ashore, for the gliders were still in evidence and might not have been able to resist the temptation of a motionless target. Lackland saw the islander dive into the sea with some relief; he knew Barlennan quite well, but had not been sure just what course of action he would consider proper under the circumstances.

"Barl," he said after a few moments silence, "do you suppose you could

keep out of trouble for a few weeks, until we get our nerves and digestions back up here? Every time the *Bree* is held up, everyone on this moon ages about ten years."

"Just who got me into this trouble?" retorted the Mesklinite. "If I hadn't been advised to seek shelter from a certain storm—which it turned out I could have weathered better on the open sea—I'd certainly never had met these glider makers. I can't say that I'm very sorry I did, myself; I learned a lot, and I know at least some of your friends wouldn't have missed the show for anything. From my point of view this trip has been rather dull so far; the few encounters we have had have all terminated very tamely, and with a surprising amount of profit."

"Just which do you like best, anyway; adventure or cash?"

"Well—I'm not sure. Every now and then I let myself in for something just because it looks interesting; but I'm much happier in the end if I make something out of it."

"Then please concentrate on what you're making out of this trip. If it will help you any to do that, we'll collect a hundred or a thousand shiploads of those spices you just got rid of and store them for you where the *Bree* wintered; it would still pay us, if you'll get that information we need."

"Thanks, I expect to make profit enough. You'd take all the fun out of life."

"I was afraid you'd feel that way. All right, I can't order you around, but please remember what this means to us."

Barlennan agreed, more or less sincerely, and swung his ship once more southward. For some days the island they had left was visible behind them, and often they had to change course to avoid others. Several times they saw gliders skimming the waves on the way from one island to another, but these always gave the ship a wide berth. Evidently news spread rapidly among these people. Eventually the last visible bit of land slipped below the horizon, and the human beings said that there was no more ahead—good fixes could once more be obtained with the weather in its present clear state.

Southward they went, shifting course now and then as before to take advantage of winds predicted from above. The predictions themselves grew ever more detailed and accurate as the meteorologists grew more and more familiar with Mesklin's weird climate. One more storm was encountered, which the *Bree* weathered safely at sea —there was no land which the Earthmen could see for three thousand miles. After that the weather men were able to chart hurricane formation so far ahead that such disturbances could be completely avoided. They were maintaining a list of predicted course changes for the *Bree* as much as five Earth days ahead, and betting on their fulfillment; in a few weeks they had to offer large odds in order to find takers.

At about forty-gravity latitude they directed the ship on a more southeasterly course to avoid the land mass which, as Reejaaren had said, swung far to the east ahead of her. Actually the ship was following a relatively narrow passage between two major seas, but the strait was far too wide for that fact to be noticeable from shipboard. The *Bree* never came within fifteen hundred miles of the nearer main shore, though her course line on the great globe kept on Toorey to show her wanderings seemed to hug the coast through the passage. Once through, the heading straight south was resumed, and weight gradually continued its climb.

One minor accident occurred some distance into the new sea. At around sixty gravities the canoe, still following faithfully at the end of its towrope, began to settle visibly in the sea. While Dondragmer put on his best "I told-you-so" expression and remained silent, the little vessel was pulled up to the ship's stern and examined. There was quite a bit of methane in the bottom, but when she was unloaded and pulled aboard for examination no leak was visible. Barlennan concluded that spray was responsible, though the liquid was much clearer than the ocean itself. He put the canoe back in the sea and replaced its load, but detailed a sailor to inspect every few days and bail when necessary. This proved adequate for many days; the canoe floated as high as ever when freshly emptied, but the rate of leakage grew constantly greater. Twice more she was pulled aboard for inspection without result; Lackland, consulted by radio, could offer no explanation. He suggested that the wood might be porous, but in that case the leaking should have been present from the beginning. It was difficult to picture the almost metal-hard, close grained wood of Mesklin's trees ever becoming waterlogged in any case, light as it was.

The situation reached a climax at about two hundred gravities, with more than a third of the sea journey behind them. The minutes of daylight were longer now as spring progressed and the *Bree* moved ever farther from her sun, and the sailors were relaxing accordingly. The individual who had the bailing job was not, therefore, very attentive as he pulled the canoe up the stern rafts and climbed over its gunwale. He was aroused immediately thereafter. The canoe, of course, settled a trifle as he entered; and as it did so, the springy wood of the sides gave a little. As the sides collapsed, it sank a little farther—and the sides yielded more—and it sank yet farther—

Like any feedback reaction this one went to completion in a remarkably short time. The sailor barely had time to feel the side of the canoe pressing inward when the whole vessel went under water and the outside pressure was relieved. Enough of the cargo was denser than methane to keep the canoe sinking, and the sailor found himself swimming where he had expected to be riding. The canoe itself settled to the end of its towrope, slowing the *Bree* with a jerk that brought the entire crew to full alertness.

The sailor climbed back into the *Bree*, explaining what had happened as he did so. All the crew whose duties did not keep them elsewhere rushed to the stern, and presently the rope was hauled in with the swamped canoe at the end of it.

Lackland was calling for explanations, interspersing the request with repetitions of the standard human complaint that the vision sets were never pointed quite right when anything interesting happened. With some effort, the canoe and such of its load as had been adequately lashed down were hauled aboard, and one of the sets turned to view it. The object was not very informative; the tremendous resilience of the wood had resulted in its recovering completely even from this flattening, and the canoe had resumed its original shape, still without leaks. This last fact was established after it had once more been unloaded.

Lackland, looking it over, shook his head and offered no explanation. "Tell me just what happened—what everyone who saw anything at all did see."

The Mesklinites complied, Barlennan translating the stories of the crewman who had been involved and the

few others who had seen the event in any detail. It was the first, of course, that provided the important bit of information.

"Good Earth!" Lackland muttered, half aloud. "What's the use of a high-school education if you can't recall it when needed later on? Pressure in a liquid corresponds to the weight of liquid above the point in question—and even methane under a couple of hundred gravities weighs a good deal per vertical inch. That wood's not much thicker than paper, either; a wonder it held so long. I wonder if it would hold up at a decent temperature; it seems to have sprung back after being I suppose, almost completely flattened—"

Barlennan interrupted this rather uninformative monologue with a request for information. "I gather you now know what happened," he said. "Could you please make it clear to us?"

Lackland made an honest effort but was only partly successful. The concept of pressure, in a quantitative sense, defeats a certain number of students in every high-school class. There was nothing wrong with Barlennan's brain, but his background was considerably less scientific, in the sense denoting familiarity with the idea of precise measurement, than the average human child's. His people were still many generations from the idea of longitude determination by precise time measurements, for example, though they were good cartographers where dimensions could be measured directly—good enough, as Barlennan had revealed long since, to have detected the curvature of their planet's surface in their surveys.

He did get the idea that the deeper one went into the sea the greater was the crushing force, and that the rate of increase with depth went up along with gravity; but he did not connect this force with others such as wind, or even the distress he himself had experienced when he submerged too rapidly in swimming. Perhaps this was natural, considering the fact that a pressure change great enough for him to notice in this way would have reduced a human body to pulp.

The main point, of course, was that any floating object had to have some part of itself under the surface, and that sooner or later that part was going to be crushed if it was hollow. He avoided Dondragmer's eye as this conclusion was reached in his conversation with Lackland, and was not comforted when the mate pointed out that this was undoubtedly where he had betrayed his falsehood when talking to Reejaaren. Hollow ships used by his own people, indeed! The islanders must have learned the futility of that in the far south long since.

The gear that had been in the canoe was stowed on deck, and the voyage continued. Barlennan could not bring himself to part with the now useless little vessel, though it took up a good deal of space. He disguised its uselessness thinly by packing it with food supplies which could not have been heaped so high without the sides of the canoe to retain them. Dondragmer pointed out that it was reducing the ship's flexibility by extending the length of two rafts, but the captain did not let this fact worry him.

Time passed, as it had before, first hundreds and then thousands of days. To the Mesklinites, long-lived by nature, its passage meant little; to the Earthmen the voyage gradually became a thing of boredom, part of the regular routine of life. Most of them returned to research jobs that had been more or less interrupted by the whole affair. Others, of course, could not do that; their lines of research hung on the data that Barlennan was

trying to recover. These, and people like Lackland and Professor McKnight whose prime interest lay either in the voyage itself or in Mesklin's people, kept a more or less faithful watch on the vision screens while the *Bree* crossed the endless miles of sea month after month.

They watched and talked to the captain as the line on the globe slowly lengthened; measured and computed to determine his position and best course when he asked them to; taught English to or tried to learn a Mesklinite language from sailors who sometimes also grew bored; in short, waited, worked where possible, and killed time as four Earthly months—nine thousand four hundred and some odd Mesklinite days—passed. Gravity increased from the hundred and ninety or so at the latitude where the canoe had sunk to four hundred, and then to six, and then further, as indicated by the wooden spring balance that was the *Bree's* latitude gauge. The days grew longer and the nights shorter until at last the sun rode completely around the sky without touching the horizon, though it dipped toward it in the south.

The sun itself seemed shrunken to the men who had grown used to it during the brief time of Mesklin's perihelion passage. The horizon, seen from the *Bree's* deck through the vision sets, was *above* the ship all around, as Barlennan had so patiently explained to Lackland months before; and he listened tolerantly when the men assured him it was an optical illusion.

The land that finally appeared ahead was obviously above them, too; how could an illusion turn out to be correct? The land was really there. This was proved when they reached it; for reach it they did, at the mouth of a vast bay that stretched on to the south—if any direction this close to the south pole could be called that—for some two thousand miles, half the remaining distance to the grounded rocket.

Up the bay they sailed, more slowly as it finally narrowed to the dimensions of a regular estuary and they had to tack instead of seeking favorable winds with the Flyer's help, and finally to the river at its head. Up this they went too, no longer sailing except at rare, favorable intervals; for the current against the blunt faces of the rafts was more than the sails could usually overcome, broad as the river still was.

They towed instead, a watch at a time going ashore with ropes and pulling; for in this gravity even a single Mesklinite had a respectable amount of traction. More weeks, while the Earthmen lost their boredom and tension mounted in the Toorey station. The goal was almost in sight, and hopes ran high.

And they were dashed, as they had been for a moment months before when Lackland's tank reached the end of its journey. The reason was much the same; but this time the *Bree* and its crew were at the bottom of a cliff, not the top. The cliff itself was three hundred feet high, not sixty; and in nearly seven hundred gravities climbing, jumping, and other rapid means of travel which had been so freely indulged at the distant Rim were utter impossibilities for the powerful little monsters who manned the ship.

The rocket was fifty miles away in horizontal distance; in vertical, it was the equivalent, for a human being, of a climb of nearly thirty-five—up a sheer rock wall.

[*To be concluded.*]

Editorial

THE VILLAINS OF THE PIECE

I HAVE learned that more than forty-five per cent of the men in the United States are below average in height; that over forty per cent of the children in the country are subnormal in intelligence for their age, and that over forty-seven per cent of the population suffers from subaverage health. That, furthermore, it is still true that one third of the nation is ill-clothed, ill-housed, and ill-fed. More important, I have discovered the group in this country that has produced these shocking statistics—a group whose intention it is to maintain those conditions for all time to come!

Every word of the above statements can be proven in full. It may seem surprising that a non-news magazine like this one, without the help of outside investigators, has been able to uncover this widespread plot; it merely indicates the complete failure of our more widely touted investigative agencies to carry out the work they should have done.

There is such a group of people; a single, relatively small part of our population has brought those statistics into being, and is manipulating things to see to it that they stay that way. So long as this group operates, no one can hope to change that situation!

Who are these villains?

The statisticians, of course. They defined "average" in such a way that as many units are above the average point as there are below. So long as they maintain that definition, more than forty-five per cent of the men in the country *have* to be below average in height.

So long as the definition of "normal" remains what it is, more than forty per cent of the children of the country *have* to be subnormal. And since our concept of "normal" is derived as it is—why, it's also true that one-third of the millionaires in this country are ill-housed, ill-fed and ill-clothed by millionaire-standards.

The statistical method of information handling an analysis can be of immense service to humanity; the difficulty is that it is one of the most complex and tricky systems of handling facts that Man has invented yet. Statistical methods are used when, and only when, the situation involved is too complex to be handled by a more direct technique. If the factors involved in a problem can be separated out, statistical methods are unnecessary. By the nature of things, therefore, statistical methods can be expected to be extremely confusing, extremely hard to evaluate, and almost certain to constitute a trap for the unwary.

The statistical items listed above, for instance, depend on the fact that there are certain facts that are-by-definition, and an entirely different set of facts that are-by-nature. The height of a man in inches is a number; the number is dependent on two factors—the arbitrarily defined length called "one inch" and the fact-of-nature, the man's height.

English language can add to the confusion. There's the Lincoln story illustrating that. "If you call a dog's tail a leg," someone asked him, "how many legs does a dog have?"

"Four," said Lincoln. "Calling a tail a leg won't make it one." Too many people are willing to "call it a leg" and come up with a five-legged dog.

Proper use of statistics demands a careful determination of the definitions used, the recognition of the difference between fact-by-definition and fact-by-nature, and an acute recognition that the subject is *not* simple. Statistics can be blithely quoted to prove anyone's prejudice. A favorite form of error is the "A goes with B. This shows that A causes B." Some thoroughly well-intentioned people have written serious articles based on that fallacy. A favorite instance is the set of statistics that shows that there is more nervousness among people who smoke than among nonsmokers.

It can also be shown that medicine makes people sick; there is more sickness among people who consume medicine than there is among nonconsumers of medicines.

Statistical curves also show that the number of cases of cancer reported in the United States has shown a steadily rising curve that is paralleled almost precisely by the steady rise in consumption of milk. Of course, it also parallels the rise in consumption of electric power, the rise in highway mileage, and the rise in population —which latter might, possibly, explain all the others, when you think of it.

The one that science-fictioneers run into most commonly, though, is the curious statistical proposition—for that's what it actually is—that since nobody has ever been able to do X, that means that X can't be done. We aren't having quite as much trouble with that argument as we used to; the usual process of introducing an X that couldn't be done involves a slow, gradual growth from theory to laboratory to experimental demonstration to gradual introduction; like radio broadcasting, or television, for example. The atomic bomb helped break that old false-statistics argument; its introduction was *not* gradual. It was entirely secret, until it was, abruptly, a fact.

Actually, the usual "You can't do that; nobody can!" argument is based on a sort of subliminal argument "People have been trying to do something like that for a thousand years. They haven't done it. The odds against it are, then, millions to one. It can't be done."

The falsity in this statistical reasoning is simply that the statistics have nothing whatever to do with "doing X"; they all concern not-doing-X, which is an entirely different subject. You do not have any statistics whatever regarding doing-X until you have at least one instance when X was, in fact, done. Statistics on not-doing-X have no bearing at all, as *statistics*. It's possible to get statistics—i.e., numbers—on the subject of how many trees in this country do *not* bear apples. Until we also have some statistics on how many trees *do* bear apples, we can't get any probability computations, however.

Finally, another gross statistical error involves trying to use statistics on a nonhomogeneous universe, or a disturbed universe. Suppose I tried to get statistics on the number of professionally employed airplane pilots who could read Braille; I might get a number, but no one knows what the meaning of that number would be. It's a "disturbed" universe, in that reading Braille is a learning of the blind, and airplane pilots are necessarily sighted. Imagine a mathematician trying to get statistics on the fall of dice—and having a professional crap-shooter roll the dice. The situation would be "disturbed," but good!

And statistics on telepathic phenomena are equally invalid; telepathy

is, admittedly, an anomalous occurrence. The phenomenon is *not* part of the normal-average-common universe of ordinary human talents. One of the most serious errors one can make is to decide that a truly anomalous occurrence is a mere statistical irregularity, and try to treat it as such. Any anomalous performance can be called a statistical irregularity, or statistically unimportant, and ruled out of consideration. Statistically speaking, there is no significant quantity of cobalt in the human body—but you'll die of pernicious anemia without the cobalt-based vitamin B-12. Statistically speaking, averaging the total mass of the Earth's crust, there is no gold—merely a minute statistical irregularity.

And Mercury's orbit was only forty seconds of arc per century off the Newtonian predictions. Slight statistical error, possibly—

But because physicists don't work that way, Einsteinian factors were sought out and a new cosmology appeared.

Some individuals have displayed telepathy. But that's a mere statistical irregularity, of no significance. Ignore it. Pay no attention. You can see it's statistically insignificant, and besides, all we know of the human mind and the nature of communication shows the idea is nonsense.

You wouldn't want to have to revise all your thinking about the nature of thought, would you?

THE EDITOR.

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MODERN STYLE ROCKETS

WILLY LEY'S account makes it clear that the hand-craftsman style of production would not make rockets practicable in modern use for any purpose other than entertainment. Too much hand labor, and waiting around for things to dry—too much judgment and experience and skill of the workman required. Pounding the powder home is possible—but it isn't something for happy little morons to play with.

The mass-produced military rockets of today do the job differently. The fuel load in the airplane-carried attack rockets, for instance, is a solid stick of a special plastic material. It may be an injected molded plastic, or a cast material. It may be four feet long, and have a cross section like a Maltese Cross, or some other complex multilobed shape. Several such plastic rods may be used in one rocket.

The rocket chamber is made of steel, and has a more or less conventional rocket throat.

The plastic rod is a very special, exceedingly combustible compound, based on a highly nitrated organic compound, of the general family of TNT or picric acid. They can be made fast, by machine, and don't require skilled human labor; they are also quite reliable and thoroughly destructive.

SECRET

By LEE CAHN

The plans *for the full testing of the guided missile were most carefully planned; one does, when trying out an active, atomic-armed missile! The plan did not include sabotage . . .*

Illustrated by Cartier

MINUTES of the Senate Committee on Military Affairs. May 10, 1962.

Senator Guy: Your name and occupation, please.

Mr. Schlosberg: William Schlosberg, engineer.

Senator Guy: What is your connection with the guided missile *Albatross V?*

Mr. Schlosberg: I was Assistant Project Engineer for guidance, for the entire contract.

Senator Guy: What were the principal specifications for the *Albatross V?* You may talk freely here.

S.: *Al* had an atomic power plant, so his range was unlimited. Maximum speed was Mach 5—

G.: How fast is that in miles per hour?

S.: About twenty-eight hundred miles an hour at service ceiling, which was one hundred twenty thousand feet. Warhead was twenty-five hundred pounds—the missile was designed to take a *Mark VII* warhead, but I was never officially told its Radius of Kill. I understand unofficially it exceeded thirty miles. Len Johnson was Project Engineer on the warhead for the A.E.C.

G.: How about the guidance system?

S.: Accuracy was supposed to be plus or minus one mile anywhere on Earth. It was supposed to be invulnerable to the countermeasures expected to be available in 1962. In fact, the whole missile was supposed to be invulnerable. Yall Aircraft has been in the missile business for fifteen years, and *Al V* was the best we could make. It's all written up in the specs and the proposal.

G.: I have here a top secret letter from General A. S. Frederick of the Air Development Force. It asks you to make ready one *Albatross V* for live firing on March 21, 1961. What did you do when you received this letter?

S.: Well, first I canceled the March 1st firing, so we would be sure to have one good missile. Then I went down to the shop and tried to have Number Seven expedited so that if Five and Six failed we would have another chance. They promised they would, but Seven wasn't ready until June 4th.

G.: Did you write to the Joint Chiefs?

S.: Yes, sir, I did.

G.: What did you write?

S.: I asked them not to use *Al* for a tactical mission. I knew it was; they don't fire live for practice.

G.: Why did you advise them not to use your missile, Mr. Schlosberg? Did you know what was going to happen?

S.: No, sir, I did not. *Al V* was still in his engineering test phase. These were handmade models, and we still had plenty of bugs to get out. He just wasn't ready. But they wouldn't listen.

G.: I have here your biweekly Progress Report for the first half of February. It says that all major difficulties have been overcome, and future emphasis will be on production planning. How do you explain that?

S.: Oh, that's just the Progress Report. Don't believe any of that. Uh, that is, the writing of Progress Reports is affected by other considerations than test results. The higher echelons tend to be somewhat optimistic when dealing with the government. *I* never stated that all difficulties were overcome, sir.

G.: That's all right, Mr. Schlosberg. No one is going to tell Yall Aircraft what you say here. We need the truth. What reason did the Joint Chiefs give for firing *Al* over your objections?

S.: Well, it seems Intelligence had them all steamed up over the sensational new enemy defense weapons, and *Al's* specs sounded real good. And they HAD read that biweekly. Besides, this firing was to enforce an ultimatum, and for psychological reasons it just HAD to go through.

G.: I see. Your tone expressed some skepticism over the specifications. Did your missile meet them?

S.: Well, we met each one at least once, but we had not then hit 'em all at the same time. It takes time to create something reliable and trustworthy, with machines and people.

G.: Who was responsible that the missile be in operating condition on March 21, 1962?

S.: I was, sir, and Lavasseur, system engineer for that missile, was responsible to me. He checked the operation of every part of the system, and we both observed the results on the automatic checkoff panel. It was all right, all right.

G.: Including the warhead trigger?

S.: No, sir, that was A.E.C. classified, and we never saw it or knew how it worked. The warhead crew handled that after we were done. The missile people are never allowed to know anything about the cargo. Security, you know. We just take it to the target. From there on it's on its own. This is all written up in the contract. Have you read the contract and the specs?

G.: Perhaps you could tell us how the missile is given its instructions.

S.: A stack of punched I.B.M. cards are inserted into the orders slot. The cards are punched on the autobriefer according to the destination, flight program, special defensive instructions, et cetera.

G.: What instructions were you given for this mission?

S.: I was given no instructions, sir. General White's aide, Colonel Saunders, who had been taught how to use the autobriefer, went into the Briefing Room, locked himself in, and prepared the cards. The machine has a consistency circuit built in, which catches most of the impossible instructions. We were not told anything about the target, but we all knew it was Moscow. Security, you know. Any of my crew members who were present will confirm this. That's how we knew it was wrong. When *Al* took off east, he couldn't be going to Moscow; Moscow is pretty much north of Muroc along a geodesic. Levasseur and I looked at each other, and then went down to my office. We have a duplicate card punch and playback unit there, to check the missile cards, and to help in data reduction. We played back the flight Colonel Saunders had plotted from the duplicate cards. *Al* was heading for Washington, D. C.; time of flight seventy-four minutes.

G.: What did you do when you realized that?

S.: First I had a couple of my own people grab General White and Colonel Saunders, and lock them up. I didn't find out until later that "Saunders" was an enemy spy, and that White was merely his dupe. I couldn't take chances. Second I called Washington, the Pentagon. It took me eight minutes to get the Air Force Chief of Staff, and one more to get the President.

G.: Please try to remember your conversation as accurately as possible, Mr. Schlosberg. This is a delicate matter.

S.: Yes, sir. Well, they took it pretty calmly, I guess. Not much double-talking.

G.: But what did they *do?*

S.: First General Allen designated *Al* as hostile, and ordered out the interceptors and the antiaircraft.

G.: What effect did they have?

S.: Not very much. He flew over and past all the planes and most of the SA missiles. As I said, the interceptor hasn't been made that could shoot *Al* down. At least two SA missiles came within countermeasure range, and *Al* detonated both prematurely. Works something like a radar beacon. It's universal; fits any proximity fuse, including our own. It was developed originally for *Al III*, but it just got done in time for us.

G.: What did the President do next?

S.: He told me to hurry up and call *Al* back. I explained that countermeasures made command-type missiles obsolete years ago, and that once *Al* was launched he was on his own. If I had put anything in *Al* to bring him home, the enemy could have captured him with it.

Then General Allen barked: "Well, what are your radar frequencies, pulse widths, and rep rates? Maybe we can jam it and deflect it into the ocean. It's your baby, Schlosberg; you must know what will stop it."

But for three years, we had all thought of every way we could to stop *Al*, and we had thought of the counter for each way, and built it in. If there *was* any way, I couldn't think of it in sixty minutes if I

hadn't in three years. My job was to build an invulnerable missile, and I thought I had.

In answer to General Allen's specific question, *Al* used no radiation to locate himself, and therefore could not be confused by radiation. You can't jam it if it doesn't receive. This seems to me the best solution to the jamming problem; otherwise you lose yourself in a hopeless maze of frequencies, codes, decoders, and espionage. We rejected radar from the start.

Then the President got worried about Washington; couldn't decide whether to evacuate or not. Only a small fraction of the people could get out from under in sixty minutes, and a lot would be killed in a wild scramble. Of course, they would be killed if they stayed, except maybe they would shoot *Al* down. General Allen remembered my protest, and asked me what the chances were *Al* would fail; that one of these unsuspected bugs would crop up. Well, we were running about one failure per two hundred minutes of operation, or one chance in three of failure. No guarantee that the failure would prevent *Al* from hitting his target, of course.

The President finally decided not to evacuate and to delay the warning until the regular warning system spoke up. It would thus seem a surprise attack from the enemy, which would strengthen the nation's resolve and our moral position before the world. If he announced that one of our own missiles was coming in, it would raise the devil with morale and national unity, not to mention his prestige. We would be the laughingstock of the world. Anyway, not many could be saved. He had his own plane stand by, however, and another for the Pentagon brass.

We were all sworn to secrecy, and no paper would dare print a story like that. Even if we did talk, it would only be a rumor, and they were already as bad as they could be. The committee will have to decide if it wants to disclose this episode to the general public.

General Allen proposed a lot of foolish schemes; we had anticipated all of them. Some of his defense people's tricks were quite clever, although none of them quite made it. I learned a lot from them which I will pass on to the *Al VI* project engineer.

G.: The committee is quite grateful to you, Mr. Schlosberg, for being so frank with us. Others who were involved were not so open. Could you tell us, finally, why your missile crashed inside the Pentagon courtyard without detonating? No statement has ever been released.

S.: I take a bitter pride in the fact that *Al* went precisely where he was told, well within his specified accuracy. He did not explode because the warhead trigger was sabotaged, by an enemy spy in the bomb crew. Despite their fetish of super security the A.E.C. harbored a viper.

G.: Those Communists are subtle! Scare us to death for an hour, and then complete the psychological destruction by not detonating it!

S.: Oh, they'd gladly swap the psychological damage for a good, solid explosion, Senator. I asked the bomb-crew spy why he did it, before the G-men took him away. It seems that "Saunders" worked for the Red Army Intelligence, while the warhead saboteur was an M.V.D. man. They just weren't co-ordinated.

THE COG

By CHARLES E. FRITCH

A neat little piece about the man who didn't make it; he had to stay behind when the first ship left for space . . .

THE crowds had come early and stayed long, bringing their families as though on a picnic. They sat close to each other on the massive lawn where they ate packed sandwiches of ham and jelly and drank warm soft drinks and cool coffee. And they waited, droning like a great hive. The sun glinted from the shiny silver metal of the spaceship *President*, which towered above them like a silver monument and cast a giant needle's shadow that shrunk into itself as the morning grew old.

James Maxwell sat and listened to the quiet drone of bee-voices murmuring through the morning stillness, and he knew what had brought many of them here—curiosity, for some; mere awe of the unusual, for others. But the rest, especially the younger ones, the ones straining star-filled eyes to see—he well knew the feeling they felt, the utter, indescribable exhileration, the longing.

Longing? He wondered if anyone had ever known a longing as he had, and in the same thought knew with a selfish bitterness that they had; he felt a knot of remembrance tighten in his throat, and he wondered how many of those youngsters would satisfy that urge, and how many, many more would fail their desires, as he had failed, and take up respectable jobs in the community to become standard cogs in the machinery of society.

And yet they needed cogs, or the machinery would not run. Suppose everyone was a spaceman, then what? The world needed doctors and lawyers and even government officials. Everyone, from the President down to the lowliest laborer, was a cog. The spacemen, themselves, were cogs. He felt secure in the thought that it was more than a rationalization.

And then, suddenly, he wasn't sure, and he stared into the bright sky and wondered, as he often did, what it might have been had he followed Gerard Adams twenty years ago.

Gerard had felt that same longing, that beckoning of the stars. He had known that desire that came inexorably on the wings of night when stars blink their welcome through the cool blackness. Gerard, too, had stopped and stared into the velvet sky—and had seen his destiny there.

Gerard Adams had been the first man to land on the Moon.

He had died, of course—in space where he should have died, for that was his destiny and he would not have had it otherwise. He had tried for Mars and failed, and his rocket had disintegrated into fragments too small to be recognized.

James Maxwell wondered how *he* would die. In bed, probably, an old man hardly capable of reaching the medicine on the table beside him—much less the stars!

It seemed at times a cruel joke that fate had prepared for him, but there it was and what could he do? The answer was the same as it had always been: Nothing. Maybe tomorrow, he'd said; prepare for law so you can make a living while getting ready to go into space with Gerard and the others. That and the pressure of relatives. He used to feel cheated and clench his fists in savage denial of his destiny. But now he stood quietly by, staring at the sky, with no rationalizations to offer. Not one.

WELLS

A speaker rose and the crowd hushed expectantly, waiting to hear magic words from the many amplifiers surrounding them. The man spoke, but James Maxwell did not listen. The voice boomed out over the sun-swept listening crowd, and the tall spaceship watched the sun go down the sky and it stretched an impatient shadow-finger across the people who came to pay it homage. The man spoke of the glories of the conquest of space, the glorious infancy of space travel.

Space travel was indeed young, James Maxwell knew, a mere twenty years, enough to mature a fast-growing science—and enough to age a man. The thought was sheer torture, and he fought to subdue it.

This was hardly the way to put the thought from his mind, though. Not by being here beside this enormous needle pointing the direction to heaven. Not by feeling its enormity so close and personal, towering significantly over the cogs that had made its existence possible.

James Maxwell let his gaze wander up, up, up along the smooth metallic contours, beyond the hundreds of tons of steel and quartz and wire and plutonium to the blueness that stretched to infinity. In an hour the rocket would be out there among that blueness. In less than an hour, the crowds would be cleared away and watching with rapid hearts at a safe distance, as the rocket belched orange flame and rose into the sky on a tower of fire.

If only he were aboard.

The thought was there, frank and unashamed. If only he could desert the life he now had, exchange it for that of the lowliest crewman aboard. If only—

He almost laughed aloud at the thought. It was too late; years too late. Other men would go aboard the *President*. Younger men trained for just such a purpose. Training also fit certain cogs in certain places. He had studied law—the machinery had shifted, making room. It was that simple.

The young spacemen stood on the speakers' stand, shifting nervously, pride on their clean-scrubbed faces, smiling, proud of their roles and yet humble with all of space looking down at them. James Maxwell looked carefully into the face of each one, reading the thoughts there—his own thoughts, unrealized. He was envious, of course, but he was not bitter, and he was glad that he was not bitter. This was the way it had to be.

The First Lady rose and walked, amid a great cheering, to christen the spaceship. Her champagne bottle smashed across the tail fin, splashing frothing liquid, and a huge cheer welled and broke among the crowd. They laughed and whistled and clapped and cheered, and the warm afternoon air carried the glad sounds aloft where they seemed to linger even when the cheers had subsided.

James Maxwell felt a part of that enthusiasm. He felt his blood rushing through his body as though it were on fire, and his heart pounded a glad excitement. These people, many of them wanted to go, but they would have to go by proxy—and they were satisfied. And suddenly, he realized that he, too, would be satisfied; he would be represented even more than the others. It would be as though he, personally, were soaring through the depths of space on wings of fire!

A man's voice was crying over the loud-speaker: "Ladies and gentlemen. The President of the World Republic!"

The voice echoed from the spaceship and rose over the crowd and into space, and, amid the new ovation, James Maxwell cleared his throat and stepped forward.

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